



# Alaska Water Export



**northern**economics inc.

*In association with*  
Alaska's Best Water ♦ MWH

Prepared for the  
**Denali Commission**  
December 2003



# Alaska Water Export

**Draft, not for citation**

*Prepared for*

**Denali Commission**

**December 2003**

*Prepared by*

  
**northern**economics inc.

880 H STREET, SUITE 210, ANCHORAGE, ALASKA 99501

**T:** 907.274.5600 **F:** 907.274.5601

**E:** [norecon@norecon.com](mailto:norecon@norecon.com) ♦ [www.northemeconomics.com](http://www.northemeconomics.com)

*In association with*

**Alaska's Best Water**  
**MWH**

## **PROFESSIONAL CONSULTING SERVICES IN APPLIED ECONOMIC ANALYSIS**

### **Anchorage**

880 H St., Suite 210, Anchorage, AK 99501

**TEL:** 907.274.5600 **FAX:** 907.274.5601

**President & Principal Economist:** Patrick Burden, M.S. **Vice President & Senior Economist:** Marcus L. Hartley, M.S. **Senior Consultant, Planning Services:** Caren Mathis, MCP, AICP **Economists:** Leah Cuyno, Ph.D., Ken Lemke, Ph.D., Jonathan King, M.S. **Policy Analyst:** Nancy Mundy, Ph.D. **Socioeconomic Analyst:** Don Schug, Ph.D. **Analysts:** Michael Fisher, MBA, Cal Kerr MBA **Office Manager:** Stephanie Cabaniss **Document Production:** Terri McCoy

---

### **Bellingham**

1801 Roeder Ave., Ste. 124, Bellingham, WA 98225

**TEL:** 360.715.1808 **FAX:** 360.715.3588

**Associate Economist:** Hart Hodges, Ph.D.

**Economist:** Tamer Kirac, M.A.

**Analyst:** Kelly Baxter-Porteen, M.S.



**northern**economics inc.

**E-mail:** [norecon@norecon.com](mailto:norecon@norecon.com) **Web:** [www.northemeconomics.com](http://www.northemeconomics.com)

---

# Contents

Section	Page
<b>Abbreviations .....</b>	<b>v</b>
<b>Executive Summary .....</b>	<b>ES-1</b>
Project Tasks .....	ES-1
Project Results.....	ES-1
Water Resources .....	ES-2
Water Industry .....	ES-3
Regulatory Framework.....	ES-3
Public Benefits .....	ES-4
Financial Analysis, Results.....	ES-4
<b>Introduction, Discussion .....</b>	<b>I</b>
The Denali Commission .....	1
Project Tasks .....	1
Project Scope .....	2
Project Team.....	2
Project Results.....	3
Project Research, Sources.....	4
Conversions .....	4
Report Organization.....	4
<b>Water Resources.....</b>	<b>6</b>
Global Water Use.....	6
Global Water Resources .....	8
Water-Rich Countries.....	10
Water Stress and Scarcity.....	10
Water Issues.....	12
<b>Pacific Rim Water Resources .....</b>	<b>13</b>
California Water Demand .....	14
<b>Alaska Water Resources .....</b>	<b>16</b>
Early Russian Water Exports.....	16
Alaska's Precipitation.....	17
Alaska's River Systems .....	18
Southeast Water Resource.....	20
Southcentral Water Resources .....	21
Aleutian Water Resource .....	22
Market Preference.....	22
<b>Water Industry .....</b>	<b>24</b>
Bulk Water Export.....	24
Export Bulk Water Markets, Desalination.....	26

Bottled Water Process.....	28
Bottled Water, Market Attributes.....	30
Bottled Water, Market Summary.....	34
Alaska Bottled Water Producers .....	34
Alaska Bottled Water, Export Shipments.....	36
<b>Regulatory Framework.....</b>	<b>40</b>
Bottled Water .....	40
Glacial Water Resource.....	43
Glacial Ice.....	43
<b>Public Benefits .....</b>	<b>45</b>
Bulk Water Evaluation.....	45
Bottled Water .....	45
<b>Financial Analysis .....</b>	<b>49</b>
Bulk Water Capital and Operating Costs .....	50
Financial Analysis, Bulk Water Export.....	54
Financial Analysis, Bottled Water Export.....	54
Sensitivity Analysis .....	56
Break-even Analysis .....	59
<b>Summary, Market Opportunities .....</b>	<b>60</b>
Alaska Bulk Water Export Potential .....	60
Alaska Bottled Water Export Potential .....	60
<b>Appendices.....</b>	<b>62</b>
<b>Appendix A—References.....</b>	<b>63</b>
<b>Appendix B—Conversion Table .....</b>	<b>77</b>
<b>Appendix C—Bulk (Raw) Water Tanker Export— Sitka, AK to Long Beach, CA .....</b>	<b>78</b>

<b>Table</b>	<b>Page</b>
Table 1. Aggregate Water Use, World Averages.....	6
Table 2. Recommended Basic Water Requirement .....	8
Table 3. Selected Water Rich Countries, Population and Cubic Meters of Water per Capita, 2000. ....	10
Table 4. Africa and Asia, Selected Countries, with Water Stress, Scarcity, Cubic Meters of Water Per Capita, 2000.....	11
Table 5. Selected Conversion Costs, \$ per Acre-foot, 1,000 gallons and Cubic Meter. ....	12
Table 6. Pacific Rim Countries, with Population and Water Supply, Cubic Meters Per Capita. 2000.....	13
Table 7. Alaska’s Largest Rivers, by Area and Estimated Discharge per Second.....	19

Table 8. Global Bottled Water Market, 1997 – 2002, Quantity and Growth per Year. ....	30
Table 9. Global Bottled Water Consumption, Per Capita, Selected Countries, Gallons Per Capita. 1997 – 2002.....	31
Table 10. US Bottled Water Consumption, 1992 – 2002, Gallons Per Capita.....	31
Table 11. Leading Bottled Water Brands, US, Wholesale Sales, Share and Growth, 2001 – 2002.....	33
Table 12. Known Alaskan Water Producers .....	35
Table 13. Estimated Capital Costs, Bulk Water Export, 28,000 Acre-Foot Per Year, Sitka to Long Beach. ....	51
Table 14. Estimated Operating and Minor Maintenance Costs perTrip, Bulk Water Export, Sitka to Long Beach. ....	53
Table 15. Summary of Annual Costs, Bulk Water Export (28,000 Acre Feet), Sitka to Long Beach. ....	54
Table 16. Bottled Water Pro Forma Income Statement .....	55
Table 17. Bulk Water Cost per Acre-Foot by Decile .....	57
Table 18. Bottled Water Raw Material Price Assumptions .....	58
Table 19. Bottled Water Profit Before Taxes by Decile.....	58

<b>Figure</b>	<b>Page</b>
Figure 1. The Earth’s Water Distribution. ....	9
Figure 2. Population Growth, Contiguous United States, 1990 to 2000.....	14
Figure 3. Potential Water Supply Crises, by 2025, Western US. ....	15
Figure 4. Alaska Precipitation.....	18
Figure 5. Alaska’s Major River Systems, Discharge.....	20
Figure 6. Bulk Water Export, Sitka to Long Beach, Tanker Route....	25
Figure 7. Trend, Water Cost, Desalination versus Imported Water, 1990 to 2002.....	28
Figure 8. Alaska’s Best Water, Process Flow. ....	29
Figure 9. US Bottled Water Consumption, Gallons Per Capita, 1992 to 2002.....	32
Figure 10. Lykes Lines. Route Map, Anchorage to Tokyo. ....	37
Figure 11. Shipping Route, Alaska, Tacoma, Horizon Lines LLC. ....	38
Figure 12. Maersk Shipping Route, Dutch Harbor to Yokohama ....	39
Figure 13. Alaska Water Bottling, Regulatory Oversight. ....	42





---

## Abbreviations

AAC	Alaska Administrative Code
ABW	Alaska's Best Water
AWWU	Anchorage Water and Wastewater Utility
CFR	Code of Federal Regulations
CGMP	Current Good Manufacturing Processes
ED	Electrodialysis
FAO	United Nations Food and Agricultural Organization
FDA	US Food and Drug Administration
GDP	Gross Domestic Product
MED	Multiple-effect Distillation
MFD	Multi-state Flash Distillation
MWD	Metropolitan Water District
MWH	formerly Montgomery Watson Harza
POL	Petroleum, Oil, Lubricant
RFP	Request for Proposal
RMA	Risk Management Association
RO	Reverse Osmosis
TDS	Total dissolved solids
UAF	University of Alaska, Fairbanks
USGS	United States Geological Survey
VC	Vapor Compression
UN	United Nations



---

## Executive Summary

In June of 2003, The Denali Commission, based in Anchorage, Alaska, requested a study of *the rural development opportunities, costs, and logistics of shipping and marketing new domestic water supplies outside of Alaska*.

Northern Economics, Inc., also based in Anchorage, submitted a successful proposal, with the assistance of MWH (formerly Montgomery Watson Harza), consulting engineers, and Alaska's Best Water, a water-bottling firm serving markets in southcentral Alaska.

## Project Tasks

The Denali Commission requested specific responses to 12 different tasks, as listed in the Request for Proposal (RFP):

1. Conduct a literature search of government and private studies and reports from the past 10 years.
2. Identify and analyze three market segments: bulk water, non-premium bottled water and premium bottled water.
3. Analyze competition for potential Alaska water exporters.
4. Specify Alaska's water export potential.
5. Conduct an analysis of bulk water transportation via tanker, barge, and bag.
6. Develop capital and operating costs.
7. Discuss bulk versus bottled water operations.
8. List Alaska water sources.
9. Develop and list the regulatory framework for processors, both state and federal.
10. Project likely costs of distribution and marketing.
11. Prepare a set of pro forma financial statements.
12. Describe public benefits from potential water export operations.

## Project Results

Project research and analysis generated several key points, listed below and discussed in greater detail within the full report.

- Alaska has a considerable freshwater resource, much of it near tidewater.

- Southern California is the nearest bulk water market, with Los Angeles, Long Beach and San Diego considered potential off-loading sites.
- Bulk water export via tanker appears to be more feasible than pipelines, barges, or water bags, given the distances from Alaska's ports to southern California.
- Bulk water cost, delivered by tankers, is more expensive than current desalinization costs in the southern California area.
- The long term cost trends for on-water (tanker) delivery show rising costs, primarily through increasing labor and fuel costs.
- Desalinization costs show a steady downward trend, especially since the early 1990s, and that trend is expected to continue.
- Increasingly, bottled water is becoming a commodity, due to highly efficient plants operated by major bottlers such as Pepsi and Coca-cola, Vivendi, and other low-cost producers.
- Alaska's water bottlers face high transportation costs to most markets, markets that are already served by major low-cost producers.
- Bottled glacial water has significant market appeal in domestic and export markets, especially in southeast Asia.

## **Water Resources**

Global water use shows wide variation among the three principal uses—agriculture, industry, and municipal/human use. Water supplies vary with geography, latitude, climate, and elevation, and are expressed in terms of cubic meters of water resource per capita.

### **Global, Pacific Rim, Alaska**

Greenland, at one extreme, has over 10 million cubic meters of fresh water per person, while Kuwait, at the other extreme, only has 10 cubic meters of water resource per person. On average, the US has 10,837 cubic meters of water resource per capita, while Alaska has 1,563,168 cubic meters per capita (second only to Greenland).

Pacific Rim countries have a wide variety in population and water supply. Countries (states) with an abundance of water include Vietnam, Russia, Hawaii, Alaska and Canada. Countries with less water include South and North Korea, China and Taiwan, and Japan.

Alaska has considerable volumes of high quality, freshwater, both on a per capita and absolute basis. In 1980, the USGS estimated "Alaska contains more than 40 percent of the Nation's surface-water resources."

## **Water Industry**

For this project, the water industry was segmented into bulk and bottled groups, discussed below.

### **Bulk Water Export**

Bulk water delivery within Alaska and other locations can be as simple as 5-gallon bottled water delivery by trucks, such as that provided by ABW in southcentral Alaska. Another common method is delivery by tanker trucks in parts of rural Alaska, including Fairbanks, Homer, and even Ketchikan. Trucks capable of hauling 500 and 1000-gallon loads deliver potable water to homes (or businesses) for storage in cisterns or special water tanks.

For purposes of this project, bulk water export was defined as raw water loaded in Alaska and transported to specific markets out of state. Southern California was selected as the nearest destination for costing purposes.

### **Bottled Water Process, Market Summary, Export**

Water bottling is relatively straightforward. First, water is drawn from one of several possible sources; second, depending on raw water characteristics, it may or may not be filtered, purified, or treated (for bacteria); and, third, it is bottled, labeled and distributed to market.

Bottled water sales and consumption has shown a steady increase over the past ten years, with annual growth in the 8 to 10 percent per year range. As the market has grown, soft drink bottlers, such as Pepsi and Coca-Cola have entered the market and used their economies of scale to become low-cost producers.

Bottled water has been shipped from Anchorage to Japan, where there is relatively strong market interest for glacial and Alaska water.

## **Regulatory Framework**

Export water quality—raw or food-grade—will determine which set of regulations, federal or state, will apply. Raw bulk water has the least regulatory oversight. Bottled water is regulated by the federal Food and Drug Administration as a food product, while tap water is regulated by the U.S. Environmental Protection Agency and is regarded as a utility.

Water is classified as “bottled water” or “drinking water” if it meets all applicable federal and state standards, is sealed in a sanitary container, and is sold for human consumption. Bottled water cannot contain sweeteners or chemical additives (other than flavors, extracts or essences) and must be calorie-free and sugar-free.

## **Public Benefits**

Public benefits from either type of water processing include jobs, taxes, royalties, and conservation fees. These are highly dependent on the specific type of process, how it is funded, and organization of the local public sector.

The state, with conservation fees of \$10 per acre-foot (estimated) is not likely to receive significant revenues from water bottling plants. Bulk water exports of 45 acre-feet per tanker would generate \$450 in conservation fees per export shipment

If Sitka receives \$0.01 per gallon in royalties (similar to a current contract), a single tanker carrying 14.7 million gallons of water would generate \$147,000 in payment to Sitka.

## **Financial Analysis, Results**

Exports of raw bulk water are not cost-competitive at this time with current desalinization technology, although the political process often incorporates other measures and values in the decision making process. Bottled water exports are feasible and sales to countries such as Japan and Taiwan could capitalize on Alaska's image and its glaciers.

### **Bulk Water Costs**

Bulk water costs were estimated based on markets in southern California, a 2,200 nautical mile trip, served by bulk water from Sitka. Capital costs for 18 single-hulled tankers capable of 620 total trips per year are \$350 million. Operating and maintenance costs, including a royalty cost of \$0.01 per gallon in Sitka, suggest delivered costs of water would be \$7,900 per acre-foot.

Current costs for desalinated water in southern California range from \$130 per acre-foot (brackish water) to \$1,200 per acre-foot for saltwater. Water distribution costs of \$100 to \$300 per acre-foot suggest a range of \$230 to \$1,500 per acre-foot.

At these costs, delivered costs of Alaska water would be at least five times more expensive than the competitive process.

### **Bottled Water Costs, Revenues**

Bottled water plants are viable businesses in Alaska. In most instances, local Alaskan markets provide base demand and revenues. Exports, if successful, are an incremental increase in production. Bottled water that features glacier water can be a viable export business from an area such as Anchorage, with Eklutna Glacier water and Port of Anchorage container berths.

A bottled water plant, capable of producing and selling up to 400,000 cases per year, could generate \$1.5 million in revenue and,

using industry-based figures, earnings of approximately \$110,000 before taxes.

The bottled water analysis assumes that the business has about \$2.2 million in total assets, including \$500,000 of bottling and packaging equipment, a 2,000 square foot building valued at \$250,000, and \$35,000 in office and delivery equipment.

Five people are employed to cover all aspects of production, marketing, and administration. The business produces 300,000 cases of water annually, at a cost of \$2.67 per case, and sells each case for \$5.00 wholesale. Under these assumptions, the business has revenues of \$1.5 million.

Sensitivity analyses and simple break-even calculations are included in the main report. Two appendices provide information on a literature search (Appendix A) and water conversion factors (Appendix B). A full version of bulk water cost assumptions and calculations is included as Appendix C.





---

## Introduction, Discussion

In June of 2003, The Denali Commission, based in Anchorage, Alaska, requested a study of *the rural development opportunities, costs, and logistics of shipping and marketing new domestic water supplies outside of Alaska.*

The project report would be a single source of information on potential water processing and export from Alaska, for both bulk and bottled operators. A prospective water bottler or shipper could take the report and use it to identify opportunities and constraints, along with order-of-magnitude costs.

Northern Economics, Inc., also based in Anchorage, submitted a successful proposal, with the assistance of MWH (formerly Montgomery Watson Harza), consulting engineers, and Alaska's Best Water, a water-bottling firm serving markets in southcentral Alaska.

## The Denali Commission

The Denali Commission was established in 1998 as a joint federal-state partnership with five assigned areas of improvements:

1. Energy
2. Health Care Facilities
3. Training
4. Intergovernmental Coordination
5. Other Infrastructure projects such as economic development, telecommunications, washeterias, and multi-use facilities

These objectives are consistent with the Denali Commission's mandate *to provide critical utilities, infrastructure, and economic support throughout Alaska.*

Water export, either as bulk or bottled water, is a potential development for many parts of Alaska. Existing facilities in such places as Metlakatla, Hyder, Ketchikan, Hatcher Pass, and Juneau are examples. With its many miles of coastlines and deep-water ports, export water is another resource that Alaskans could ship to water-stressed countries, especially in the Pacific Rim area.

## Project Tasks

The Denali Commission requested specific responses to 12 different tasks, as listed in the Request for Proposal (RFP):

1. Conduct a literature search of government and private studies and reports from the past 10 years.

2. Identify and analyze three market segments: bulk water, non-premium bottled water and premium bottled water.
3. Analyze competition for potential Alaska water exporters.
4. Specify Alaska's water export potential.
5. Conduct an analysis of bulk water transportation via tanker, barge, and bag.
6. Develop capital and operating costs.
7. Discuss bulk versus bottled water operations.
8. List Alaska water sources.
9. Develop and list the regulatory framework for processors, both state and federal.
10. Project likely costs of distribution and marketing.
11. Prepare a set of pro forma financial statements.
12. Describe public benefits from potential water export operations.

## Project Scope

Rural Alaska is defined by the Commission as those areas that experience three criteria:

- The difficulty and cost of importing and exporting products, traveling to, and communicating with, urban centers because of distance
- The absence of, or inadequate public infrastructure
- A "one industry" village or community with a small population located in proximity to a natural resource and having cheap labor

All of Alaska, at specific times, meets the definition of *rural*. Even Anchorage has experienced difficulties with freight and passenger delivery due to strikes, bad weather, and port security issues.

Much of Alaska is remote, with no access except by air, and is subject to weather extremes such as wind, ice, extreme cold, rain and ice. For purposes of this report, all of Alaska was considered as remote.

Project team members evaluated trends, where possible, to the years 2020 or 2025, based on the best available information.

## Project Team

To help meet specific Denali Commission task requirements, Northern Economics obtained the assistance of Alaska's Best Water and engineers from MWH (formerly Montgomery Watson Harza).

**Alaska's Best Water** has provided water bottling and delivery services in Anchorage since 1983; its twenty years in business has included several analyses of export of bottled water to South Korea and other out-of-Alaska locations.

Mike Alfano, General Manager of Alaska's Best Water (ABW), provided assistance, and his company's 20 years of operating experience with water bottling, distribution, and marketing.

**MWH (formerly Montgomery Watson Harza)** has specific engineering expertise with all sizes of water delivery systems, from small individual village utilities to large municipal bulk treatment plants.

In Alaska, it was the principal engineering firm for the Eklutna water project, a complex diversion of water from hydroelectric uses to Anchorage's residents. Greg Magee, PE and MBA, was designated as MWH's lead project engineer.

**Northern Economics Inc.'s** project team included Cal Kerr, Project Manager, and Pat Burden, President of Northern Economics, who served as project economist. Mike Fisher, Analyst, prepared financial and sensitivity analyses.

## Project Results

Project research and analysis generated several key points, shown below and discussed in greater detail within major report sections:

- Alaska has a considerable freshwater resource, much of it near tidewater.
- Southern California is the nearest bulk water market, with Los Angeles, Long Beach and San Diego considered potential off-loading sites.
- Bulk water export via tanker appears to be more feasible than pipelines, barges, or water bags, given the distances from Alaska's ports to southern California.
- Bulk water cost, delivered by tankers, is more expensive than current desalinization costs for freshwater production in the southern California area.
- The long term cost trends for on-water (tanker) delivery show rising costs, primarily through increasing labor and fuel costs.
- Desalinization costs show a steady downward trend, especially since the early 1990s, and that trend is expected to continue.
- Increasingly, bottled water is becoming a commodity, due to highly efficient plants operated by major bottlers such as Pepsi and Coca-cola, Vivendi, and other low-cost producers.

- Alaska's water bottlers face significant transportation costs to markets already served by major low-cost producers.
- Bottled glacial water has significant market appeal in domestic and export markets, especially in southeast Asia.

## Project Research, Sources

Appendix A contains references and citations used for this project. Although there are over 200 separate references, they are representative of the major water-related topics from the last ten years.

Topics such as water supplies, water use, allocation, distribution, and health and sanitation are very current and likely to become more significant in the next 20 years.

## Conversions

Water is measured in many different units, from gallons of volume, to pounds of weight, including acre-feet, liters, and cubic meters. A full set of conversion tables is contained in Appendix B.

Worldwide, water volumes are measured in cubic meters and costs are generally expressed as US dollars per cubic meter. Within the US, acre-feet (the volume of water need to cover an acre of land to a one-foot depth) and units of 1,000 gallons are common.

Common conversions are as follows:

- 1 cubic meter of water contains 1,000 liters or 264.2 gallons
- 1 acre-foot of water is 325,900 gallons or 1,233 cubic meters
- 1,000 gallons of water is 3.8 cubic meters

## Report Organization

This report is organized in major sections and subsections, as generally described below.

**Introduction, Discussion.** This section provides background on the project (including tasks, scope, and the team), this report, and general findings, as well as common water conversion factors.

**Water Resources.** Global water uses, resources, and specific water-rich countries are identified, along with water issues such as continuing population growth and increased water demand.

**Pacific Rim Water Resources.** Countries and states along both sides of the Pacific Ocean area are noted as to water resources and potential demand for Alaska water. In specific, California's southern water demand is discussed in detail.

**Alaska Water Resources.** Alaska's water-rich status is noted, along with the first bulk water export (ice) in 1852. Water resources and market preferences are discussed.

**Water Industry.** Process and market attributes of both the bulk and bottled water industry segments are discussed in this section.

**Regulatory Framework.** Federal and state oversight of the bottled (and bulk) water industries are presented in this section, including special measures for glacial water and glacial ice.

**Financial Analysis.** Capital and operating costs, including maintenance, are presented in this report section, with pro forma financial statements, sensitivity analyses, and a break-even analysis.

**Summary, Market Opportunities.** Alaska's bulk and bottled water potentials are summarized in this section.

## Water Resources

Global water supply and use varies by country location, population density and degree of development. This section provides a picture of global, regional (Pacific Rim), and local Alaska water supply and use estimates, in descending geographical order.

Global water use shows wide variation among the three principle uses (agriculture, industry, and municipal – human use). Basic human needs are approximately 50 liters per day for drinking water, sanitation, bathing, and food preparation.

Water supplies vary with geography, latitude, climate, and elevation, and are expressed in terms of cubic meters of water resource per capita.

Greenland, at one extreme, has over 10 million cubic meters of freshwater per person, while Kuwait, at the other extreme, only has 10 cubic meters of water resource per person. On average, the US has 10,837 cubic meters of water resource per capita, while Alaska has 1,563,168 cubic meters per capita (second only to Greenland).

Water stress occurs when water supplies drop below 1,700 cubic meters per person, with scarcity defined as less than 1,000 cubic meters per person of annual supply.

Information on global water resources is presented in more detail within the following sections.

## Global Water Use

According to the World Bank<sup>1</sup>, world freshwater uses are categorized as shown in Table 1.

**Table 1. Aggregate Water Use, World Averages.**

Water Use	Percent of Total
Agriculture	70
Industry	20
Municipal	10

The World Bank's averages include a six-fold increase over the past century, worldwide. They do not account for high variability among (and within) countries. The bank noted:

*These increases have come at high environmental costs; some rivers no longer reach the sea; 50 percent of the world's wetlands have disappeared in*

---

<sup>1</sup> "World Bank Endorses Water Resources Strategy," News Release February 27, 2003.

*the past century and 20 percent of freshwater fish are now endangered or extinct. Many of the most important groundwater aquifers are being mined, with water tables already deep and dropping by meters every year, and some are damaged permanently by salinization. Without appropriate action taken to address the situation, **four billion people—one half of the world's population—are expected to live under conditions of severe water stress in 2025**, particularly in Africa, the Middle East, and South Asia. [Emphasis added].*

Other attributes of these three main water uses are discussed in the following subsections.

### **Agriculture**

Food self-sufficiency consumes an estimated 900 cubic meters of water per person per year, well beyond the amount available in semi-arid countries within Africa and Asia. Forecasts for the next 30 years suggest water scarcity will make these regions, home to 55 percent of the world's population, more dependent on food imports<sup>2</sup>. Africa and Asia have two of the highest regional birth rates in the world.

Agricultural water quality needs are less stringent than those for human consumption. Parts of the world, such as Israel, use reclaimed sewage and non-contaminated industrial process water for agricultural production.

### **Industrial**

Traditionally, industrial water use has been tied to industrial activity as an indicator of prosperity<sup>3</sup>. As Gross Domestic Product (GDP) increased, there was a parallel increase in water consumption by industrial firms.

However, recent technological advances have reduced water consumption in many industries, such as the steel and food industries. There is no longer the direct one-to-one linkage between GDP and industrial water use.

### **Municipal**

The minimum amount of water needed for human life ranges from 20 to 40 liters (freshwater) per day, for drinking and sanitation alone. The World Bank, the World Health Organization and the United

---

<sup>2</sup> Ibid.

<sup>3</sup> "The World's Water, 2002-2003" Peter Gleick, Island Press, 2003.

Nations set these targets. However, these volumes exclude water for cooking and cleaning.

The quantities in Table 2 suggest a minimum of 50 liters per person per day (18.3 cubic meters per person per year), for four essential uses, including personal hygiene.

**Table 2. Recommended Basic Water Requirement**

Purpose	Liters per Person per Day
Drinking Water	5
Sanitation Services	20
Bathing	15
Food Preparation	10
<b>Total</b>	<b>50</b>

Peter H. Gleick, *Basic Water Requirements for Human Activities: Meeting Basic Needs*, in Water International, International Water Resources Association, 1996.

As a point of comparison, one Anchorage subdivision, with its own water system, distributes water to approximately 250 homes. Over seven years, metered water consumption per home has averaged about 264 gallons or almost exactly one cubic meter (1,000 liters) per day.

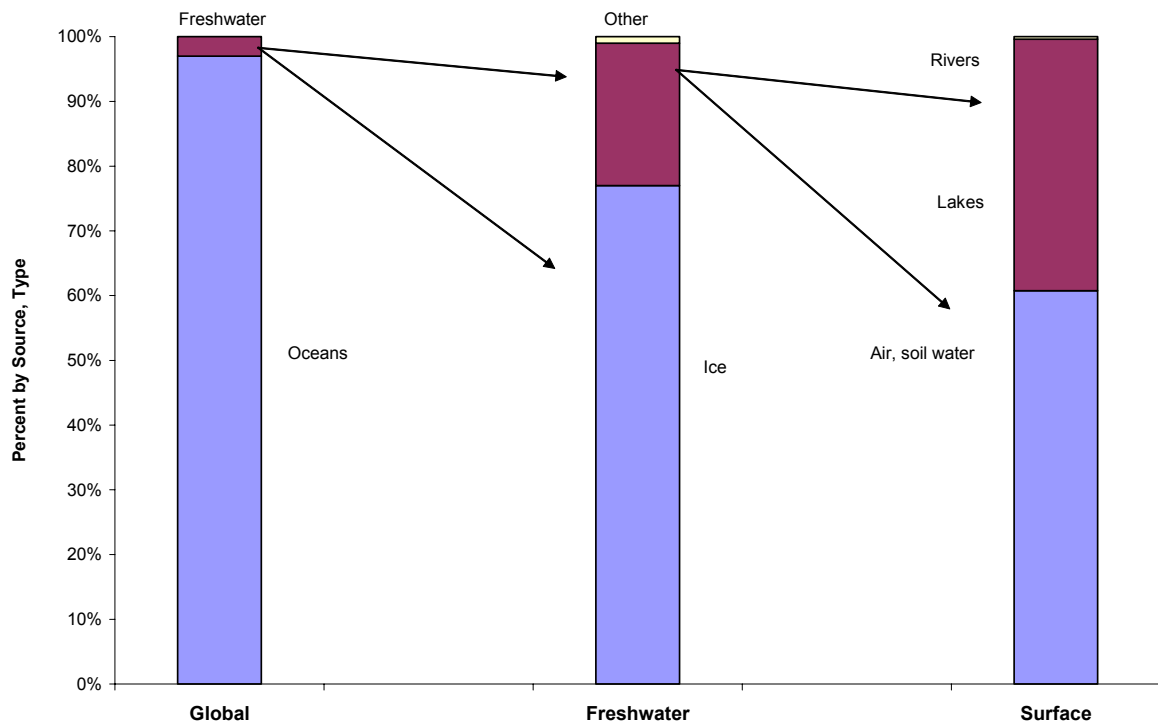
At three people per home, the per capita water consumption in this Anchorage subdivision is 88 gallons or 330 liters, about six times the established basic water requirement shown in Table 2.

## Global Water Resources

The earth is covered with water, estimated at 70 percent of the world's surface area. However, only 3 percent of that water is freshwater, with the rest contained in the Earth's oceans. Figure 1 illustrates the earth's freshwater distribution.



Figure 1. The Earth's Water Distribution.



Source: US Geological Survey, <http://ga.water.usgs.gov/edu/mearthall.html>. Accessed October, 2003.

Freshwater that readily supports human life, agricultural and industry is located in ground water, surface water, and the various icecaps and glaciers in Alaska and other countries. Alaska alone contains approximately 75,000 square kilometers of glaciers<sup>4</sup>.

Overall, there is sufficient freshwater for human use on an annual basis.

One estimate<sup>5</sup> suggests between 12.5 and 14 billion cubic meters of water are available on an annual basis, or about 9,000 cubic meters per person per year. This same methodology suggests only 5,100 cubic meters will be available in the year 2025.

Since freshwater is not evenly distributed, there are considerable supply disparities now, and they appear likely to get worse as population increases and global warming changes traditional weather and water patterns.

<sup>4</sup> <http://insidc.org/glaciers/quickfacts.html>. Accessed October 10, 2003.

<sup>5</sup> "Solutions for a Water-short World," Population Information Program, Johns Hopkins School of Public Health, September, 1998.

## Water-Rich Countries

Table 3 lists selected countries in terms of per capita water supply. Unlike thresholds for water stress and scarcity, there are no defined levels of abundance.

**Table 3. Selected Water Rich Countries, Population and Cubic Meters of Water per Capita, 2000.**

Country	Continent	Population	Water per Capita
Greenland	N C America	56,000	10,767,857
USA, Alaska	N C America	626,932	1,563,168
Papua New Guinea	Asia	4,809,000	166,563
Canada	N C America	30,757,000	94,353
New Zealand	Oceania	3,778,000	86,554
Belize	N C America	226,000	82,102
Peru	South America	25,662,000	74,546
Laos	Asia	5,279,000	63,184
Chile	South America	15,211,000	60,614
Panama	N C America	2,856,000	51,814
Colombia	South America	42,105,000	50,635
Fiji Islands	Oceania	814,000	35,074
Ecuador	South America	12,646,000	34,161
Russian Federation	Europe	145,491,000	30,980
Costa Rica	N C America	4,024,000	27,932
Malaysia	Asia	22,218,000	26,105
Australia	Oceania	19,138,000	25,708
USA, Hawaii	N C America	1,211,537	15,187
Mongolia	Asia	2,533,000	13,739
Indonesia	Asia	212,092,000	13,381
Viet Nam	Asia	78,137,000	11,406
United States of America	N C America	283,230,000	10,837

Source: United Nations, Food and Agricultural Organization, AQUASTAT, 2003.

As shown, the United States average is 10,837 cubic meters per person, with Alaska and Hawaii listed separately due to their unique water resources and smaller populations.

## Water Stress and Scarcity

Water stress and scarcity are measured in terms of available annual supply per capita:

- *Water stress* occurs when annual supplies drop below 1,700 cubic meters per person.
- *Water scarcity* is defined as annual water supplies under 1,000 cubic meters per person per year.
- *Water shortages* or rationing can be expected between the two figures<sup>6</sup>.

Africa and Asia are currently listed in those categories of water stress and scarcity, as shown in Table 4.

**Table 4. Africa and Asia, Selected Countries, with Water Stress, Scarcity, Cubic Meters of Water Per Capita, 2000.**

Continent and Country	Estimated Population	Water per Capita
<b>Africa</b>		
Libyan Arab Jamahiriya	5,290,000	113
Egypt	67,884,000	859
Morocco	29,878,000	971
Kenya	30,669,000	985
South Africa	43,309,000	1,154
<b>Weighted Average</b>		<b>947</b>
<b>Asia</b>		
Kuwait	1,914,000	10
Gaza Strip (Palestine)	1,077,000	52
Saudi Arabia	20,346,000	118
Singapore	4,018,000	149
Jordan	4,913,000	179
Israel	6,040,000	276
Cyprus	784,000	995
Korea, Republic of	46,740,000	1,491
Pakistan	141,256,000	1,576
Syrian Arab Republic	16,189,000	1,622
<b>Weighted Average</b>		<b>1,232</b>

Source: United Nations, Food and Agricultural Organization, AQUASTAT, 2003.

This information suggests countries currently experiencing water stress or scarcities are concentrated in Africa and Asia. Many of these countries are potential markets for Alaska's water or, conversely, they have developed alternative water production that is competition for water delivered from Alaska. Israel, with its heavy dependence on desalinization of salt water, is such an example.

Many parts of the world, including the United States, have invested in reverse osmosis water purification, a system that produces water in

<sup>6</sup> "Solutions for a Water-Short World," John Hopkins University, 1998.

the \$0.55 to \$0.70 cost per cubic meter. Equivalent costs are \$700 to \$900 per acre-foot or \$2 to \$3 per 1,000 gallons, as shown in Table 5. Generally, water costs are quoted in most of the world as US dollars per cubic meter.

**Table 5. Selected Conversion Costs, \$ per Acre-foot, 1,000 gallons and Cubic Meter.**

<b>\$/Acre Foot =&gt;</b>	<b>\$/1000 gallons =&gt;</b>	<b>\$/cubic meter</b>
400	1.23	0.32
600	1.84	0.49
800	2.45	0.65
1,000	3.07	0.81
1,200	3.68	0.97
1,600	4.91	1.30
2,000	6.14	1.62

## Water Issues

In 1992, the UN's Dublin Conference declared "Water has an economic value in all its competing uses and should be recognized as an economic good." Others have opposed this view, suggesting water is both a social and economic good.

Other policy issues include:

- Water rich versus water poor countries
- Developed versus undeveloped countries and water consumption
- Future for water use – by sector (agricultural, industrial, and human)
- Globalization of water trade
- Global warming impacts on water supply
- Privatization of water supply and distribution
- Large water dams
- Population growth

Generally, there is agreement that the highest priority water use is maintaining human life, followed by all others.

Although the issues noted above are beyond the scope of this project, they will have a major impact on world water use policies in the next several decades.

## Pacific Rim Water Resources

Pacific Rim water resources for selected countries are discussed in this section. Regional, or Pacific Rim, population and relative water supplies (in cubic meters per capita) are shown in Table 6. Unless otherwise noted, these are based on country averages.

West Coast United States population consists of Washington, Oregon, and California, however, the water supply shown is based on the US national average. Water supply information for specific states, such as the three West Coast US states is not readily available; population figures, however, are available by state and are shown. Water supply information for Alaska and Hawaii is available and is also shown.

**Table 6. Pacific Rim Countries, with Population and Water Supply, Cubic Meters Per Capita. 2000.**

Pacific Rim Country	Population	Water Supply Per Capita	Per Capita GDP (\$)
Vietnam	78,137,000	11,406	2,100
China	1,252,952,000	2,258	4,300
Taiwan	22,181,000	3,021	17,200
Japan	127,096,000	3,383	27,200
South Korea	46,740,000	1,491	18,000
North Korea	22,268,000	3,464	1,000
Russia	145,491,000	30,980	8,300
Hawaii	1,211,537	15,187	36,300
Alaska	626,932	1,563,168	36,300
Canada	30,757,000	94,353	27,700
West Coast, US	43,187,168	10,837	36,300
Mexico	98,872,000	4,624	9,000

Source: AQUASTAT, United Nations Food and Agricultural Organization, 2003. Census 2000, US Census Bureau; "The World Factbook" US Central Intelligence Agency, 2003.

Pacific Rim countries have a wide variety in population and water supply. Countries (states) with an abundance of water include Vietnam, Russia, Hawaii, Alaska and Canada. Countries with fewer water supplies include South and North Korea, China and Taiwan, and Japan.

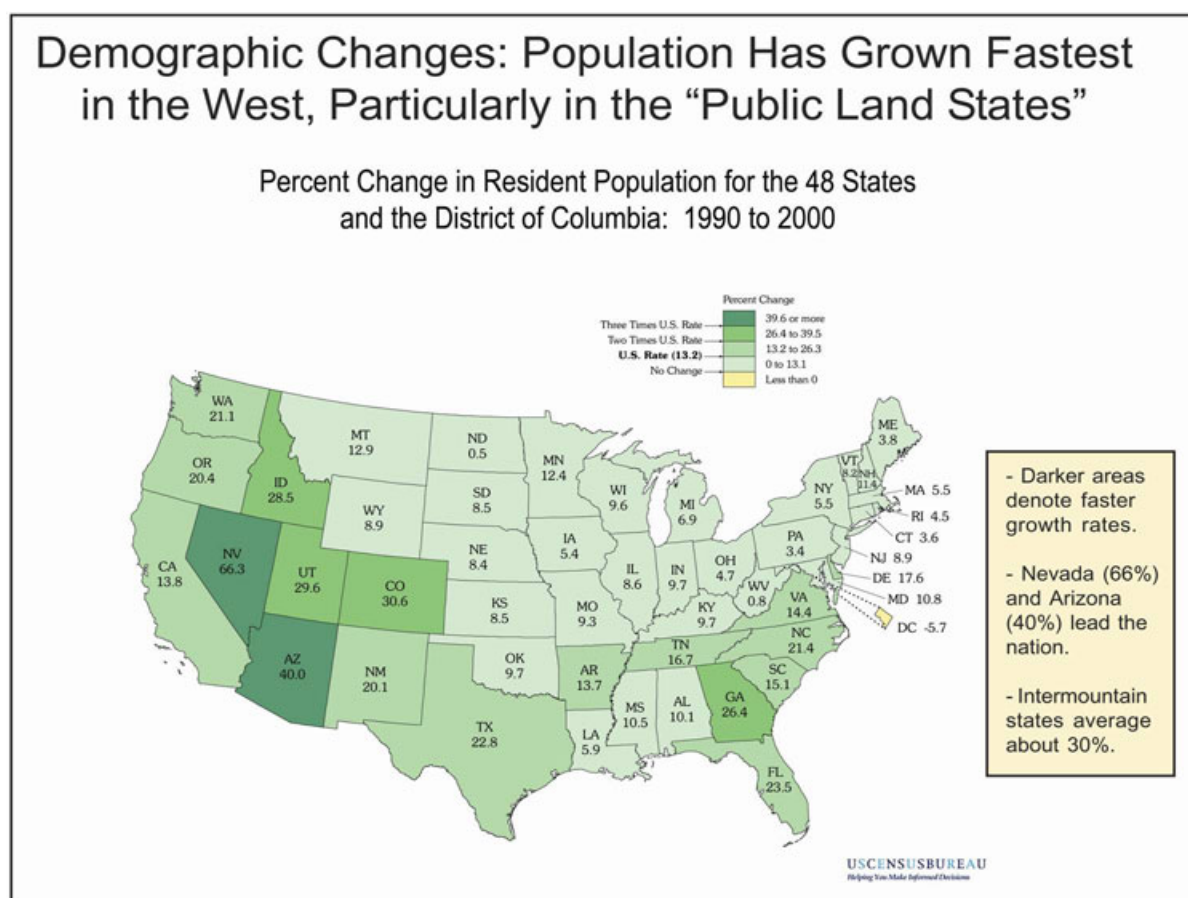
The column headed with per capita GDP provides an estimate of economic development. Generally, more developed countries have more internal funds available for water provisioning. Poorer countries often seek external funds, such as loans from the World Bank.

Washington and Oregon have smaller populations than California and overall less demand for water.

## California Water Demand

Southern California's warm, dry climate, as well as similar conditions in adjacent areas such as New Mexico and Nevada (especially Las Vegas), has contributed to considerable net in-migration in the past 10 to 15 years. Figure 2 illustrates population growth in the contiguous US for the period 1990 to 2000.

**Figure 2. Population Growth, Contiguous United States, 1990 to 2000.**

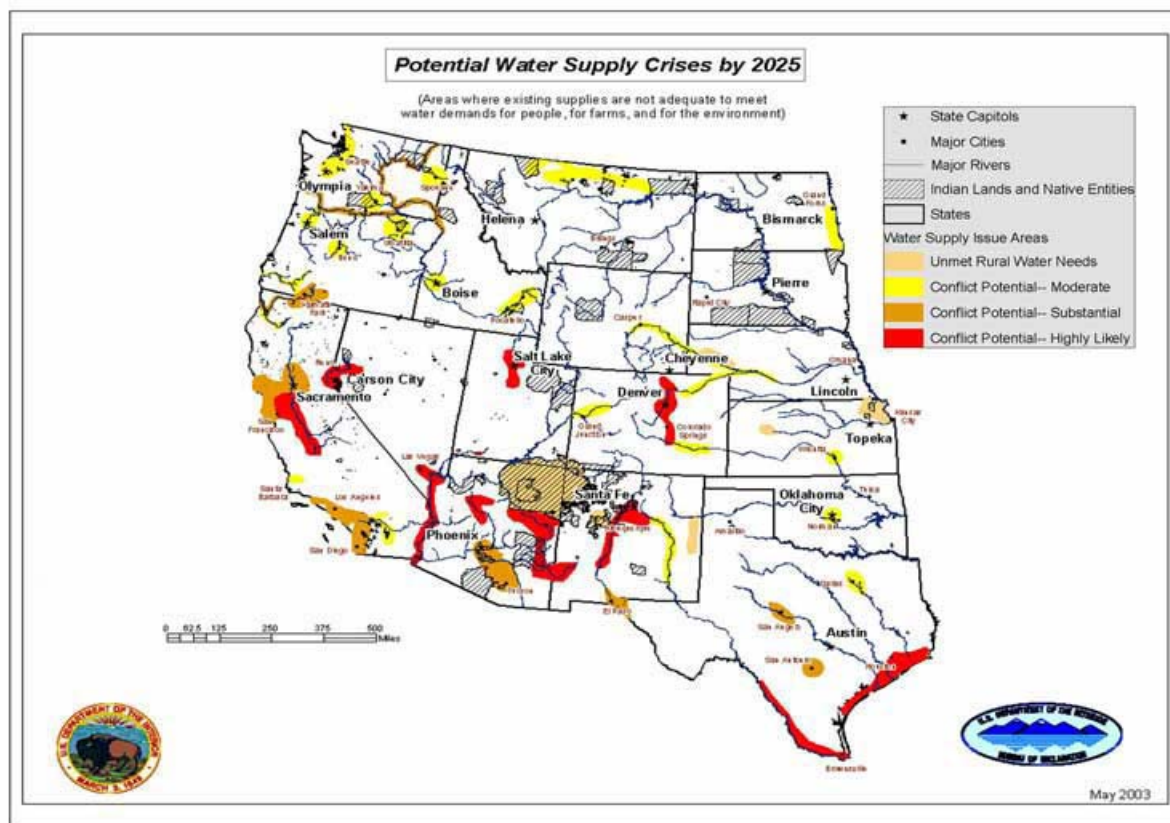


Source: US Census Bureau, <http://www.doi.gov/water2025/populate.html>, accessed December 23, 2003.

A major water source for California, Nevada, and New Mexico is an allocated portion of water from the Colorado River. Homeowners in San Diego, for example, are likely to drink water from the Colorado, shipped to the Los Angeles area and, eventually, San Diego via a series of aqueducts.

Other sources of water for the drier portions of southern California are inter-basin transfers from the northern part of the state. However, the overall picture of water supply for California to the year 2025 suggests increasing conflicts and higher demand for freshwater. Figure 3 illustrates potential water crises by 2025.

**Figure 3. Potential Water Supply Crises, by 2025, Western US.**



Source: US Department of Interior, Bureau of Reclamation, <http://www.doi.gov/water2025/supply.html>, accessed December 23, 2003.

Conflicts in the San Francisco area are considered highly likely, while there is substantial potential for conflict from Los Angeles south to San Diego.

## Alaska Water Resources

As shown in the two prior sections, Alaska has considerable volumes of freshwater, both on a per capita and absolute basis. In 1980, the USGS estimated “Alaska contains more than 40 percent of the Nation’s surface-water resources.”<sup>7</sup> The State’s average annual precipitation is about 1,050,000 million gallons per day, with an average annual surface runoff of about 989,000 million gallons per day.<sup>8</sup>

Water export from Alaska is not new, however. The first water export started with the Russians, as bulk ice shipped to west coast cities.

### Early Russian Water Exports

Bulk water export from Alaska began during the Russian era, as export ice. Slabs of ice were cut, stored in sawdust within icehouses, and eventually shipped to California and other markets.

The Russian America company operated an ice company in Alaska for 28 years. Initially established at Sitka, it moved to Woody Island in 1855, near Kodiak, and shipped ice to California, Mexico, and the Sandwich Islands (Hawaii).<sup>9</sup> The first shipment to California (San Francisco), displacing ice shipped from Boston, was so successful that the Russian America Company agreed to furnish 1,000 tons annually at \$35 per ton.

That first shipment was made in February, 1852 Woody Island to San Francisco. At \$75 per ton, the initial cargo was 250 tons, for a total sale of \$18,750. Ice was cut with a special horsed-powered saw and stored in icehouses, covered with sawdust, at Woody Island.

Sample loads of ice from Sitka were tested in 1852 and found to be too soft and thin, at three to four inches thick, and shipped loads had to be supplemented with glacial ice from Baird Glacier near Petersburg.

Woody Island produced 19,200 tons of ice in the six years that ended July 1, 1860; annual production reached 6,000 tons per ton. By July 1, 1862, 25,500 tons of ice were exported with total revenue reaching \$250,000.<sup>10</sup> Freight charges ranged from \$7 to \$8 per ton.

---

<sup>7</sup> Alaska Surface-Water Resources, National Water Summary, US Geological Survey, circa 1980.

<sup>8</sup> Alaska Water Supply and Use. National Water Summary, US Geological Survey, 1987.

<sup>9</sup> “The Woody Island Ice Company” by Gary Stevens. “Russian in North America” Proceedings of the 2<sup>nd</sup> International Conference on Russian America, Sitka, Alaska. August 19-22, 1987. Edited by Richard A. Pierce. Limestone Press. 1990.

<sup>10</sup> Ibid. Page 198.



An American, Frederick Whymper, visited Kodiak shortly before the 1867 sale of Russian America to the United States. He recorded the ice cutting process and commented on end-product markets in San Francisco, Mexico, and Central and South American ports. The ice company was purchased in 1867 by the American Russian Commercial Company. In 1868, total ice capacity was 12,000 tons in three icehouses. In 1869, ice was priced in San Francisco at five cents per pound and customers balked at the high price.

Artificial ice making began in 1871 and that started a price war in San Francisco, with Woody Island ice prices dropping to two cents per pound. Subsequently, the ice making business declined and it ceased operations by 1879.

### **Lessons Learned, Ice Exports**

Although this project took place over 150 years ago, there are lessons from the Woody Island business:

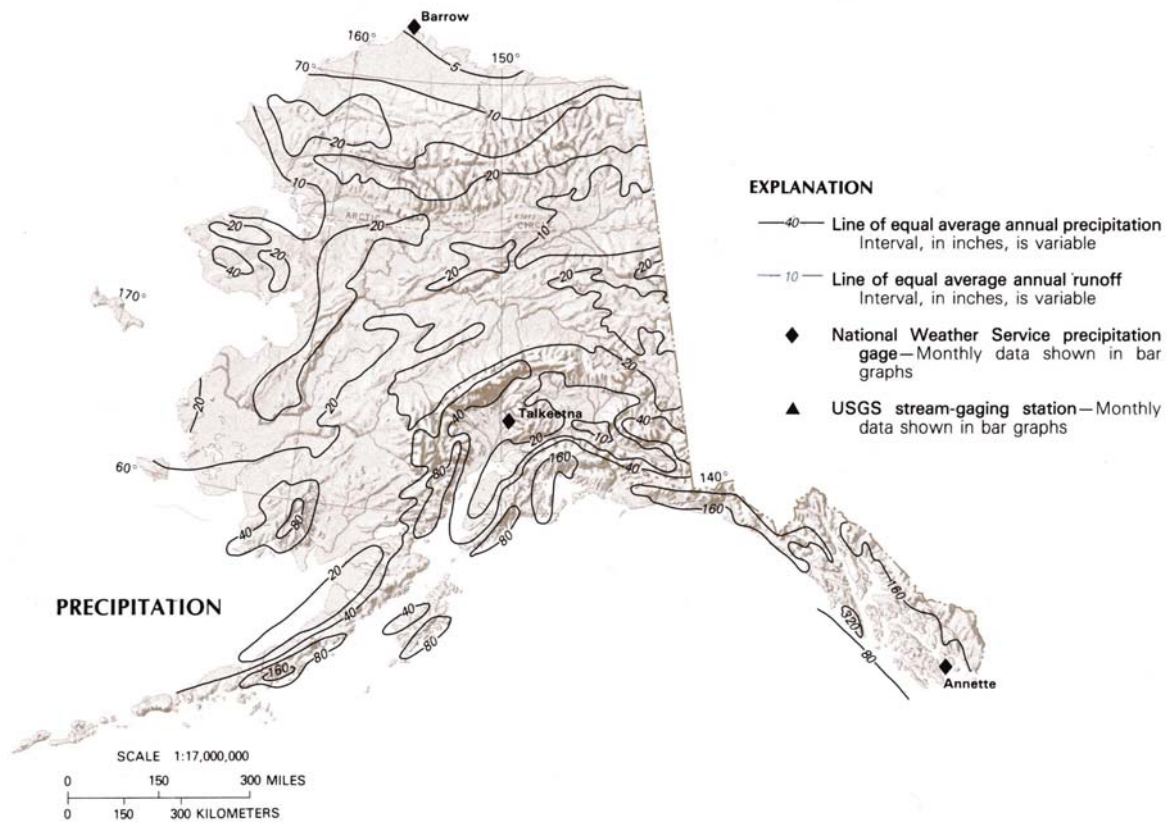
- Successful water exports (whether bulk or bottled) must overcome Alaska's distance from many markets
- Export water competitiveness is subject to technological advances, whether artificial ice-making in 1871 or cheaper desalinization plants in the current time
- Alaska has relatively limited local markets and must depend, at some point, on exports for business expansion
- Alaska has a strong name recognition and its water (and ice) has generated a favorable response from many consumers since 1852, but price is always a consideration
- Alaska's association with glaciers is a strong linkage for bottled water buyers

### **Alaska's Precipitation**

Figure 4 illustrates Alaska's precipitation in inches per year. With a land area of 586,000 square miles (1,518,000 square kilometers), there is wide variation in precipitation; from under 10 inches in the Arctic to over 300 inches per year in parts of Southeast Alaska.

In addition to surface water runoff, Alaska had 28,500 square miles of glaciers and ice fields in 1971 (Post and Mayo). There is evidence that global warming might be a cause of recent melting and calving, reducing the area and volume of Alaska's glaciers.

Figure 4. Alaska Precipitation



Source: USGS

## Alaska's River Systems

Alaska's larger rivers drain a large portion of the state. Alaska's four climatic zones have the following precipitation patterns:

- Maritime. Precipitation estimated at 67 percent of the total occurs from September to March. Ketchikan and Sitka are cities within this zone, as are Kodiak and the Aleutian chain.
- Continental and Arctic. About two-thirds of the precipitation occurs from June to November. The Yukon and Colville rivers are representative of these areas.
- Transition. This zone includes areas such as Anchorage that lie between the drier continental zone (north) and the maritime area (south).

Average rainfall for Alaska is 25 inches but a significant range exists, from 4 inches along the Arctic coast to over 400 inches for area such as Little Port Walter in Southeast Alaska.

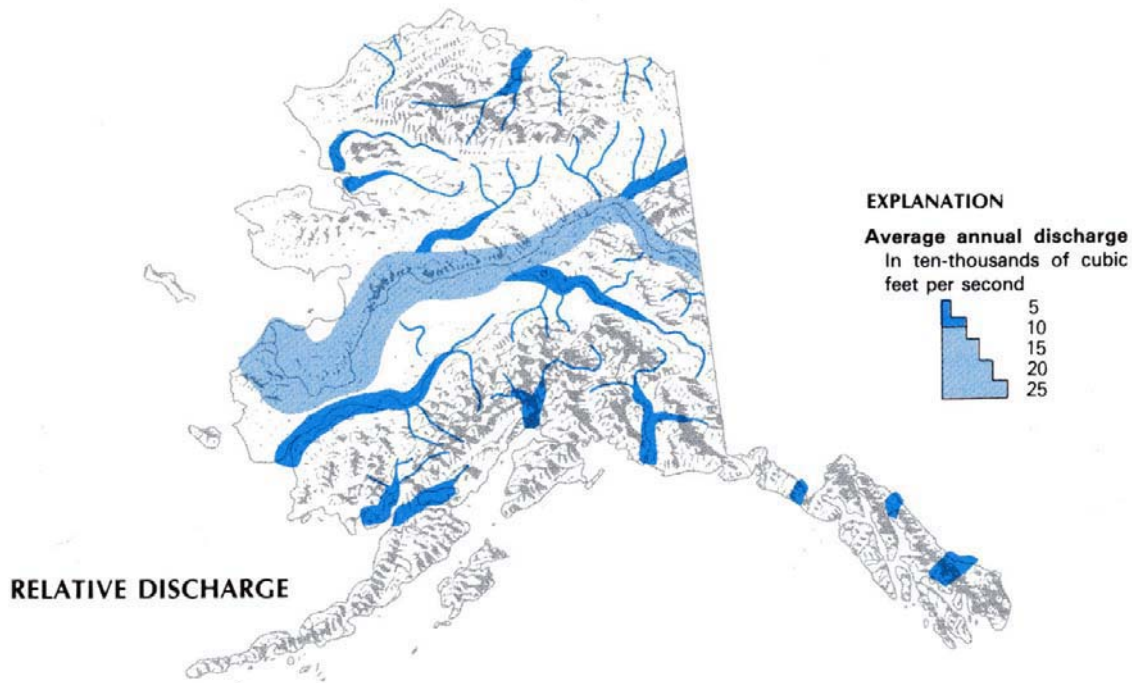
Table 7 illustrates these rivers by area within Alaska, along with estimated discharge per second (at the mouth).

**Table 7. Alaska's Largest Rivers, by Area and Estimated Discharge per Second.**

<b>River</b>	<b>Area</b>	<b>Discharge in Cubic Feet per second</b>	<b>Discharge in Cubic Meters per second</b>
Stikine	Southeast	56,000	1,977
Taku	Southeast	20,000	706
Alsek	Southeast	30,000	1,059
Copper	Southcentral	59,000	2,083
Chitina	Southcentral	20,000	706
Susitna	Southcentral	61,000	2,154
Yenta	Southcentral	21,000	742
Nushagak	Southwest	32,000	1,130
Kuskokwim	Southwest	67,000	2,366
Yukon	Northwest	225,000	7,945
Porcupine	Northwest	23,000	812
Tanana	Northwest	41,000	1,448
Koyukuk	Northwest	22,000	777
Kobuk	Northwest	18,000	636
Colville	Northwest	20,000	706

Source: Adapted from USGS, Alaska Surface-Water Resources, 1980.

Figure 5 illustrates Alaska's major river systems and their relative discharge, as displayed by the amount of shading.

**Figure 5. Alaska's Major River Systems, Discharge.**

Source: USGS

## Southeast Water Resource

In 1994, the State Department of Natural Resources (DNR) identified Southeast Alaska as a likely source of bulk exportable water.<sup>11</sup> Precipitation ranges from 100 to over 300 inches per year, mostly as rain. Surface runoff was estimated at over 300 million acre-feet per year (370 billion cubic meters).

The Southeast sub region has smaller drainage basins, less than 200 square miles, with large basins that extend into British Columbia. The Stikine River is one example. Runoff from this sub region (including the runoff from Canada) is estimated as much as that from the Mississippi River.<sup>12</sup>

The City of Sitka signed a contract for bulk water export from the city's water source at Blue Lake and Green Lake. This water source was used for bulk water costing and is explained in greater detail within report discussion on bulk water.

<sup>11</sup> Alaska Water Exports. State of Alaska, Department of Natural Resources, June, 1994.

<sup>12</sup> Alaska Surface-Water Resources. US Geological Survey. 1980.

## Southcentral Water Resources

Southcentral Alaska includes the Port of Anchorage, a receiving port that supplies over 80 percent of the state's population with food, supplies, and fuel. Water was exported from the Port in 1994 and is the only known bulk water export from this region.

### Anchorage Water Sources

The Port lies within the Municipality of Anchorage and it obtains water from the municipal water system. Municipal water is drawn from three main sources,<sup>13</sup> listed below with their supplied volumes for 2002:

- Eklutna Water Treatment Facility, 7.9 billion gallons or 79.6 percent of the total supply
- Ship Creek Water Treatment Facility, 299 million gallons or 3 percent of total supply
- Chugach Mountain Range and wells, 1.7 billion gallons or 17.4 percent of the total

The Eklutna and Ship Creek treatment facilities produce up to 65 million gallons of water per day. The Anchorage Water and Wastewater Utility (AWWU) also operates 12 high production wells and nine smaller standby units.

Eklutna water is glacial water, from the Eklutna Glacier, and meets state requirements for labeling as *glacier water*. There is further detail on glacial water in the report section titled Regulatory Framework.

### Anchorage Water Treatment

Water produced by AWWU is treated in four steps:

1. Raw water is mixed with soda ash to maintain a pH of 7.7 to 8.0, a range that minimizes corrosion in the distribution system and residential plumbing fixtures.
2. Ferric sulfate is added for coagulation and flocculation. As it dissolves, it binds dirt and other floating particles to settle in large basins.
3. Filtration through layers of anthracite coal, sand and gravel removes remaining impurities.
4. Chlorine and fluoride are added to finished water for bacterial treatment and prevention of tooth decay.

AWWU water may be metered and, if so, it is sold at the rate of \$2.64 per 1,000 gallons for both residential and commercial

---

<sup>13</sup> Anchorage Water Quality Report, Anchorage Water and Wastewater Utility, 2003.

consumers. However, AWWU residential water is billed at a flat monthly rate of approximately \$50 per home for both water and sewer.

### **Anchorage Bulk Water Export**

In August 1994, AWWU exported water to Japan from the Port of Anchorage. The 1.76 million gallons was loaded via special hoses connected to water points near the Petroleum, Oil and Lubricant (POL) dock. The tanker had loaded a partial-cargo of naphtha, along with water in the remaining holds. The ship was en route to Japan after unloading cargo in California.

The end-product consumer was a Japanese industrial user, facing extreme draught and limited industrial water availability. Grit and sand were greatest concerns for the purchaser, since the water would not be consumed by humans.

Total loading time was 16 hours, due to delays from 30-foot tide fluctuations in Cook Inlet and inadequate water-fill piping.

An engineer at AWWU estimated a 15-million gallon tanker would be a likely limit for any future such sales, due to depth limits in Cook Inlet. The system used would require three 24-hour days to fill a tanker of this size; a faster, quick-fill system was suggested for any future water sales, along with a water reservoir of appropriate size.

Exported water volume was estimated by a marine surveyor and was charged at the rate of \$2.64 per 1,000 gallons or \$4,650 for the whole load. Two other purchases were attempted but the POL dock was blocked and loading time could not be scheduled.

### **Aleutian Water Resource**

Export bulk water applications were filed with the State Department of Natural Resources in January, 2000 for Adak Island, at the western end of the Aleutian Island chain.

Three sources of surface water were identified near the former Adak military base, totaling a potential quantity of 46 million gallons per month (12,200 cubic meters).

The applications indicated water would be gravity fed by pipelines, approximately 11,500 feet in length, to a deep-water port.

Although no actual shipments have been made to date, the permits are still valid.

### **Market Preference**

Water export from Alaska is expected to continue as a spot market commodity, similar to the 1994 shipment from Anchorage. Bulk water purchasers will likely use tankers, in preference to slower tugs

or more costly pipelines. Water cost, whether \$2.64 per thousand gallons (\$0.00264/gallon) at Anchorage or \$0.01 per gallon at Sitka, is a significant cost component, given the magnitude of tanker volumes (about 15 million gallons).

## Water Industry

The water industry, including public utilities, has three main participants:

- Water producers (suppliers)
- Water distributors
- Water bottlers (wholesale, retail; 5-gallon and PET)

Producers are generally public utilities such as AWWU that supply water to commercial and municipal end-users. Several, such as the Imperial Valley Irrigation District in southern California, provide water directly to the agricultural industry.

This report section provides more specific information on bulk water suppliers, distributors and water bottlers.

## Bulk Water Export

Bulk water delivery within Alaska, and other locations, can be as simple as 5-gallon bottled water delivery by trucks, such as that provided by ABW in southcentral Alaska.

Another common method is delivery by tanker trucks in parts of rural Alaska, including Fairbanks, Homer, and even Ketchikan. Trucks capable of hauling 500 and 1000-gallon loads deliver potable water to homes (or businesses) for storage in cisterns or special water tanks.

For purposes of this project, bulk water export was defined as raw water loaded in Alaska and transported to specific markets out of state. Water tankers capable of hauling up to 15 million gallons via ocean travel were considered most feasible.

Alternatives to tanker haul include tugs towing giant nylon bags, similar in holding capacity to a tanker. However, these were considered more problematic and costly than the tanker alternative. Although there are instances where huge bags have been hauled successfully for short distances by tugs, the technology of hauling bags over long distances is still unproven (McCann, 2000).

Pipelines were also evaluated, both on-shore and offshore. However the extremely high costs of such pipelines eliminated them at this time. An order-of-magnitude cost estimate in 1992 for an offshore pipeline from southeast Alaska to Lake Shasta in northern California was approximately \$160 billion (US Congress, 1992)

Also, transporting treated (potable) drinking water was eliminated from detailed costing analysis because of the inherent problems of keeping water potable. There are a significant number of possible contamination points at loading, during hauling, and at delivery.

The most promising method of exporting bulk raw water from Alaska is a single-hull tanker. Within southeast Alaska, the City and Borough



of Sitka is actively pursuing bulk raw water sales and, with fresh water supply shortages in southern California, exporting water from Sitka, Alaska to Long Beach, California was selected for cost analysis. Figure 6 illustrates the proposed water tanker route from Sitka to Long Beach.

**Figure 6. Bulk Water Export, Sitka to Long Beach, Tanker Route.**



Source: MWH

Sitka's water is Blue Lake, fed by glacier, snowmelt and rain. Water quality is very good with total dissolved solids (TDS) less than 25 parts per million. For comparison, salt water can average 35,000 TDS.

Blue Lake supplies water for hydroelectric power as well as drinking water for the community. There is a 72" aqueduct between Blue Lake and the hydroelectric plant, flowing at 552.5 million gallons of water per day.

The City and Borough of Sitka have two water export certificates from the State of Alaska, each totaling 12.5 million gallons per day. Thus, the total water available per year from Sitka for bulk water export is 25,000 acre-feet or 9 billion gallons (Sitka, 2003). If required, Blue Lake has the capacity to provide more water.

Loading raw water at Sitka would occur at the Sawmill Cove Industrial Park, located on the shore of Silver Bay, a tidewater shipping point. Access to the aqueduct from Blue Lake is less than 2,000 feet from the shore-side dock site at Sawmill Cove. A suitable sized dock and water line would need to be constructed (Sitka, 2003).

At the receiving end in Long Beach, port facilities would need to be upgraded and a water pipeline would need to be constructed to link imported Alaska water to distribution systems managed by the Metropolitan Water District (MWD).

## **Export Bulk Water Markets, Desalination**

Southern California is the major market for Alaska's potential bulk water exports. A recent task force report (California Department of Water Resources, 2003) included the following selected key findings:

- California's population is projected to increase by 600,000 per year, largely from natural increases (births minus deaths), which will impact demands for potable water supply.
- Some areas of the State have serious groundwater overdraft problems, adding pressure on existing water supplies to meet agricultural and urban demands.
- Desalination is receiving increased attention as the cost of desalination decreases and the cost of many other water supplies continues to rise.
- There are current more than 40 brackish groundwater-desalting facilities and generate approximately 170,000 acre-feet per year.
- The total cost for brackish water desalination...will be based on site-specific conditions and currently range from \$130 to \$1,250 per acre-foot.
- There are currently 16 permitted seawater desalination facilities that generate 4,600 acre-feet per year of desalinated water in California.

- The cost for new seawater and estuarine water desalination...range from \$700 per acre-foot (energy costs of \$0.05 per kWh) to \$1200 per acre-foot (energy costs of \$0.11 per kWh). Distribution costs are \$100 to \$300 per acre-foot.
- Current desalination systems using reverse osmosis technology require about 30 percent more energy than existing interbasin supply systems currently delivering water to parts of Southern California.

### **Desalination Methodology**

There are two major types of desalination processes (International Desalination Association, 2000): thermal and membrane. Thermal processes include:

- Multi-state Flash Distillation (MFD)
- Multiple-effect Distillation (MED)
- Vapor Compression (VC)

Membrane processes include:

- Electrodialysis (ED)
- Reverse Osmosis (RO)

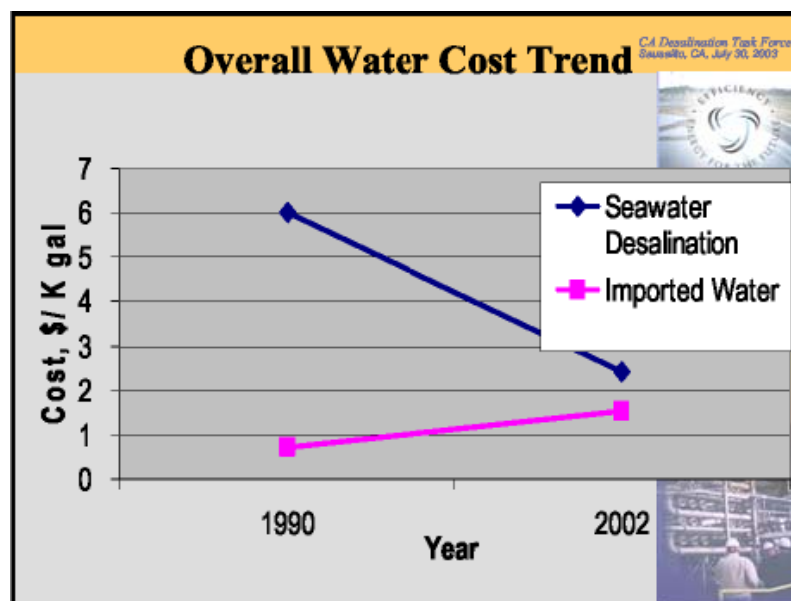
As expected, thermal processes such as MFD, MED, and VC, require considerable energy in the form of heat, from 158 degrees F up to 230 degrees F are needed to keep the processes efficient. Membrane technologies, however, require energy for pressurization and do not need high temperatures.

Most desalination plants in the world are older MFD plants (particularly in the Middle East) or RO plants, especially in areas with brackish water (Israel, Tampa Bay, Florida).

Almost all plants being planned for Southern California are RO plants with a likely cost range of \$130 to \$1500 per acre-foot, produced water cost. The latter extreme assumes \$0.11 electrical costs per kWh and \$300 per acre-foot of distribution cost.

The overall cost of desalination has shown a sharp decline since 1990, while the cost of imported water, including that from the Colorado River, has increased slightly, as shown in Figure 7.

**Figure 7. Trend, Water Cost, Desalination versus Imported Water, 1990 to 2002.**



Source: *Unit Cost of Desalination* by Shahid Chaudhry, California Energy Commission. 2003.

## Bottled Water Process

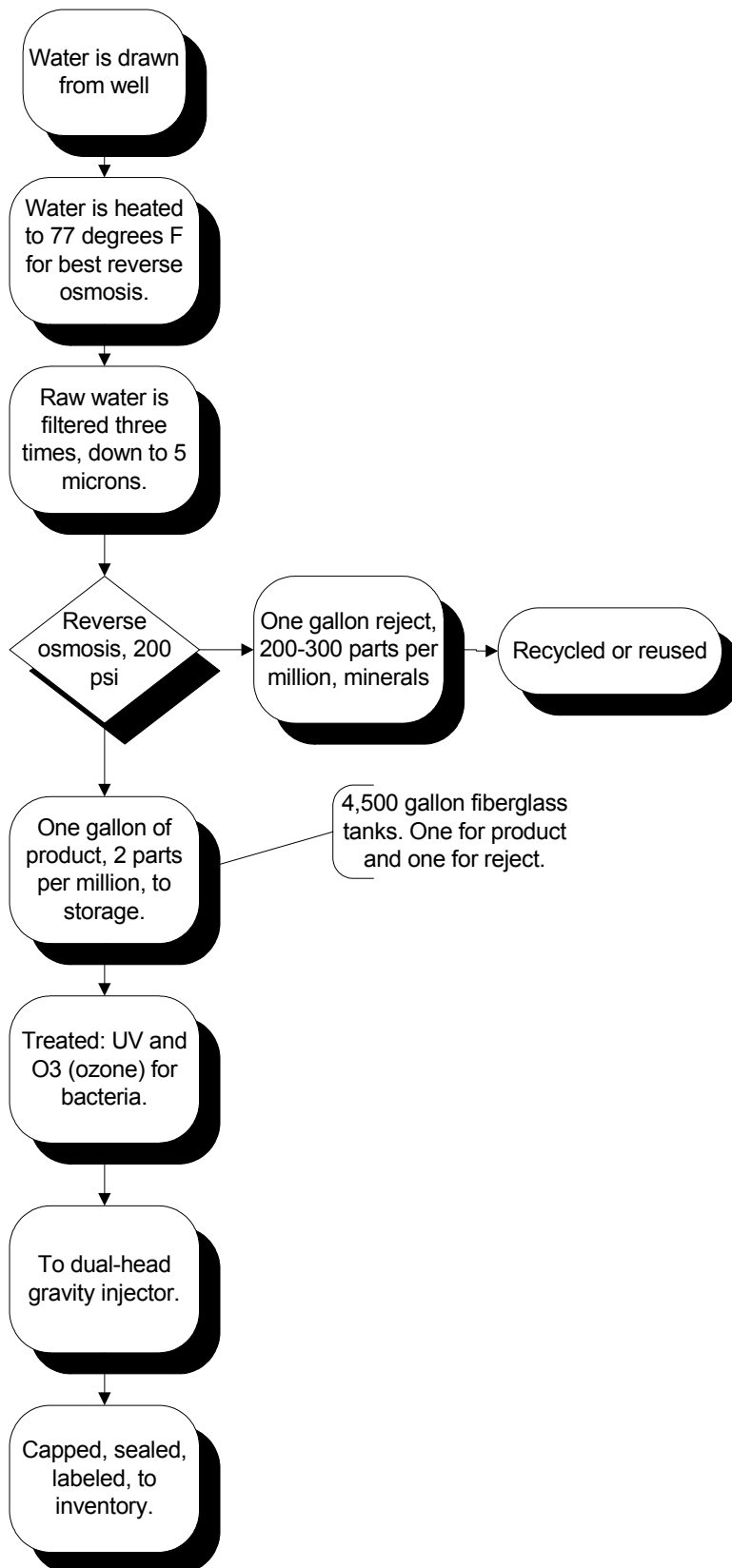
Water bottling is relatively straightforward. First, water is drawn from one of several possible sources; second, depending on raw water characteristics, it may or may not be filtered, purified, or treated (for bacteria); and, third, it is bottled, labeled and distributed to market.

Figure 8 illustrates the bottling process for ABW. The company uses raw well water as its source and then heats it to 77 degrees F for the most efficient reverse osmosis processing. It is filtered before reaching the reverse osmosis membranes, where water is pressurized to 200 pounds per square inch. Half of the in-feed water is forced through the membrane while the other half (brine, or process reject) is discarded or stored for re-use. Purified water is then treated with ultra-violet light and ozone to kill any bacteria.

ABW bottles its water in 5-gallon re-usable bottles; consumer bottles in the 0.5, 1.0 and 1.5 liter sizes are termed small-package goods or PET (an acronym for Polyethylene Terephthalate, the resin used to make these bottles). In Alaska, both Mat-Maid, Purely Alaska, and Sitka Beverage Corporation manufacture PET bottles using blow mold machines.

Virtually all bottled water export is limited to PET packaged goods. Large containers, such as the 5-gallon bottles that ABW uses, are heavy and not as consumer-friendly as PET bottles.

Figure 8. Alaska's Best Water, Process Flow.



## Bottled Water, Market Attributes

Bottled water consumption has grown steadily in the past decade.

Table 8 illustrates 2002 ranking, by country and millions of gallons consumed, for the top ten countries. These ten countries represent approximately 76 percent of all bottled water consumed in 2002. Compound annual growth rates for each country are shown, along with the worldwide average of 10.3 percent per year, since 1997.

**Table 8. Global Bottled Water Market, 1997 – 2002, Quantity and Growth per Year.**

2002 Rank	Country	Millions of Gallons				Annual % Growth 1997-2002
		1997	% of World	2002	% of World	
1	United States	3,794.30	17.8	6,018.50	17.3	9.7
2	Mexico	2,767.80	13.0	3,898.60	11.2	7.1
3	China	726	3.4	2,610.10	7.5	29.2
4	Italy	1,995.40	9.4	2,558.20	7.4	5.1
5	Brazil	1,038.00	4.9	2,541.80	7.3	19.6
6	Germany	2,166.70	10.2	2,371.50	6.8	1.8
7	France	1,598.00	7.5	2,225.60	6.4	6.8
8	Indonesia	597	2.8	1,622.50	4.7	22.1
9	Thailand	941.7	4.4	1,277.00	3.7	6.3
10	Spain	935.2	4.4	1,133.70	3.3	3.9
	Top 10 Subtotal	16,560.30	77.8	26,257.40	75.7	9.7
	All Others	4,731.10	22.2	8,435.40	24.3	12.3
	<b>World Total</b>	<b>21,291.40</b>	<b>100.0</b>	<b>34,692.80</b>	<b>100.0</b>	<b>10.3</b>

Source: Adapted from Beverage Marketing Corporation

Per capita bottled water consumption by the top 15 countries is shown in Table 9. Average worldwide bottled water consumption approximately doubled from 5.7 gallons per person in 1997 to 11.8 gallons in 2002.

**Table 9. Global Bottled Water Consumption, Per Capita, Selected Countries, Gallons Per Capita. 1997 – 2002.**

Rank	Country	1997	2002
1	Italy	35.1	44.2
2	Mexico	28.6	37.7
3	France	27.3	37.1
4	United Arab Emirates	26.8	35.2
5	Belgium-Luxembourg	30.3	32.7
6	Germany	26.4	28.8
7	Spain	23.9	28.2
8	Lebanon	13.8	24.8
9	Switzerland	22.7	24.2
10	Saudi Arabia	17.1	23.8
11	United States	14.1	21.5
12	Cyprus	17.2	21.4
13	Czech Republic	14.2	21.1
14	Austria	18.5	20.9
15	Thailand	15.8	20.1
	Global Average	5.7	11.8

Source: Beverage Marketing Corporation

Table 10 illustrates US bottled water consumption from 1992 to 2002, in gallons per capita, along with annual percent change. For the ten-year period, consumption approximately doubled from 9.8 gallons (1992) to 21.5 gallons (2002).

**Table 10. US Bottled Water Consumption, 1992 – 2002, Gallons Per Capita.**

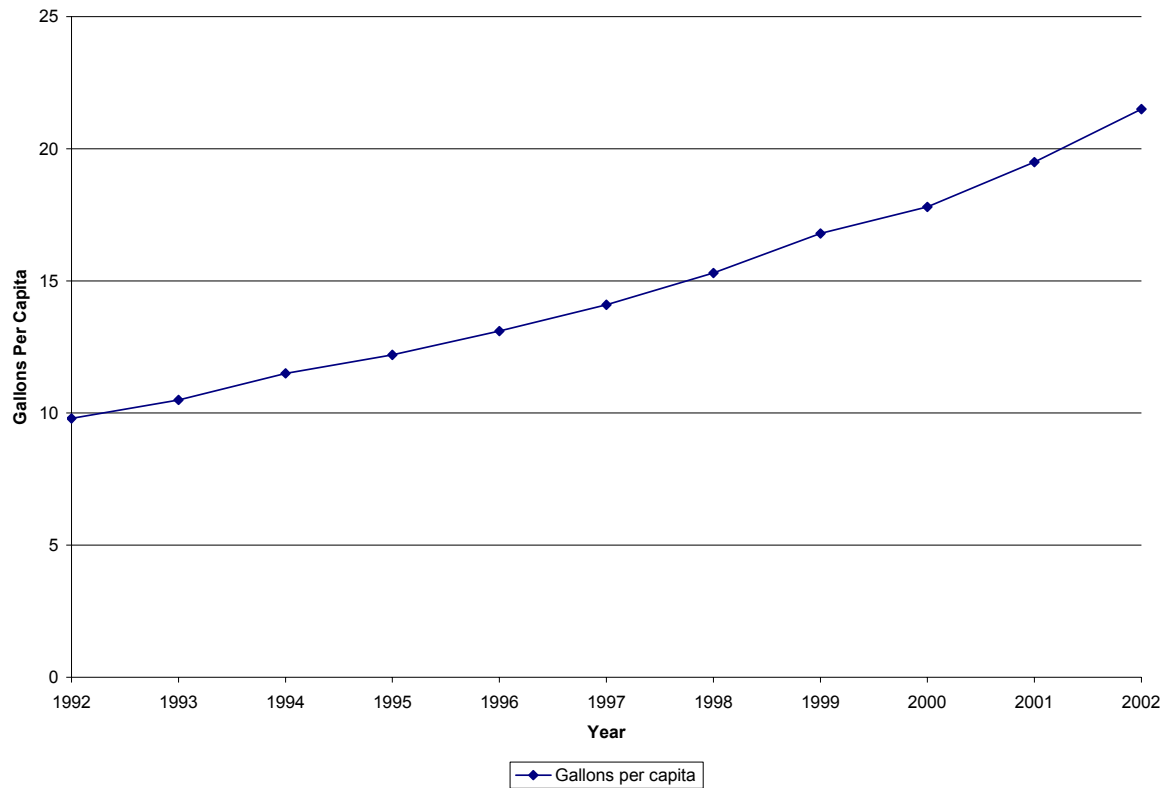
Year	Gallons Per Capita	Annual % Change
1992	9.8	—
1993	10.5	7.4
1994	11.5	9.4
1995	12.2	6.4
1996	13.1	7.4
1997	14.1	7.4
1998	15.3	8.3
1999	16.8	10.0
2000	17.8	6.0
2001	19.5	9.6
2002	21.5	10.0

Source: Beverage Marketing Corporation

Figure 9 illustrates the steady growth in US bottled water consumption, on a per capita basis, from 1992 to 2002.

---

**Figure 9. US Bottled Water Consumption, Gallons Per Capita, 1992 to 2002.**



---

Table 11 illustrates the leading bottled water brands in the US, based on wholesale dollar volume, market share, and growth, for the years 2001 and 2002.



**Table 11. Leading Bottled Water Brands, US, Wholesale Sales, Share and Growth, 2001 – 2002.**

Brands	Millions of Dollars		% Share of Sales		% Change 2001/02
	2001	2002	2001	2002	
Aquafina	\$645.0	\$838.0	9.4	10.8	29.9
Dasani	567.0	765.0	8.2	9.9	34.9
Poland Spring	542.0	621.5	7.9	8.0	14.7
Arrowhead	399.6	456.6	5.8	5.9	14.3
Sparkletts	361.8	321.4	5.3	4.2	-11.2
Deer Park	247.5	311.1	3.6	4.0	25.7
Crystal Geyser	235.0	270.0	3.4	3.5	14.9
Ozarka	183.9	209.6	2.7	2.7	14.0
Zephyrhills	184.4	202.1	2.7	2.6	9.6
Evian	211.2	191.1	3.1	2.5	-9.5
<b>Subtotal</b>	<b>\$3,577.4</b>	<b>\$4,186.4</b>	<b>52.0</b>	<b>54.2</b>	<b>17.0</b>
All Others	3,302.6	3,538.6	48.0	45.8	7.1
<b>Total</b>	<b>\$6,880.0</b>	<b>\$7,725.0</b>	<b>100.0</b>	<b>100.0</b>	<b>12.3</b>

Source: Beverage Marketing Corporation

According to a bottled water trade publication (Beverage Marketing Corporation), 2002 per capita consumption was:

- 21.2 gallons of bottled water
- 22.6 gallons of milk
- 22.1 gallons of coffee
- 21.8 gallons of beer
- 54.2 gallons of carbonated soft drinks

Market experts note soft drink consumption has declined in the past four years as other drinks have held steady or, in the case of bottled water, increased at approximately 8 to 10 percent each year.

The two main bottled water companies are Nestle Waters North America (NUNA) and Groupe Danone's Danone Waters of North America (DWNA). NUNA had five brands in the top ten: Poland Spring, Arrowhead, Deer Park, Ozarka, and Zephyrhills. DWNA had two brands in the top ten: Sparkletts and Evian, both of which lost market share.

Both Pepsi-Cola (Aquafina) and Coca-cola (Dasani) were gaining significant market share at the end of 2002. Both firms have concentrated efforts in the PET market segment, a segment that has gained share from a tenth of the market in the early 1990s to a third in 2002.

## **Bottled Water, Market Summary**

Bottled water sales and consumption has shown a steady increase over the past ten years, with annual growth in the 8 to 10 percent per year range. As the market has grown, soft drink bottlers, such as Pepsi and Coca-Cola have entered the market and used their economies of scale to become low-cost producers.

Alaska bottling firms generally confirm these annual growth figures, but face a more limited in-state market. Exporting bottled water, especially as glacial water, is a viable option and one that will become more attractive as shipping volumes increase.

## **Alaska Bottled Water Producers**

Several businesses in Alaska sell water or provide support services for water use. Table 12 shows the known water businesses in Alaska, including primary location, types of products, known markets, and relative sizes.

Anchorage and Fairbanks have a considerable number of water companies, although most Fairbanks businesses provide bulk water and delivery for the local market only. Three of the businesses shown have sold water to markets outside Alaska, primarily to locations on the Pacific Rim.

Table 12. Known Alaskan Water Producers

Company/Product Name	Location	Bottle Sizes/Types	Size of Business	Known Markets
Alaska Glacier Refreshments	Anchorage	PET	Small	
Alaska Polar Glacier Water Co.	Anchorage	PET	Small	
Alaska's Best Water	Anchorage	5 gal	Large	Anchorage, Wasilla, Palmer, Kenai Peninsula
Matanuska Maid Dairy	Anchorage	PET, 1 and 2.5 gal	Large	Alaska, Japan, Lower 48
Winter Frost	Anchorage		Small	
Alaska Pure Water Products	Anchorage	Water Treatment, 5 gal, Water Store	Large	Anchorage
Advanced Water Technologies	Anchorage		Medium	Anchorage
Aqua Alaska	Fairbanks			
Arctic Water Works	Fairbanks	Bulk: Residential Tanks	Small	Fairbanks
Fairbanks Bottled Water Company	Fairbanks	5 gal	Small	Fairbanks
Hydro-Baby	Fairbanks	Bulk Fill Point	Small	Fairbanks
Metro Water Co	Fairbanks	Bulk Deliveries	Small	Fairbanks
Pioneer Wells Water Company	Fairbanks	Bulk Deliveries	Small	Fairbanks
Silver Gulch Brewing Bottling	Fairbanks	Beer, PET?	Small	Fairbanks
Spring Alaska	Fairbanks	5 gal	Small	Fairbanks
Twin Springs Water	Fairbanks	Bulk Deliveries	Small	Fairbanks
Water Wagon	Fairbanks	Bulk and Bulk Fill Point	Small	Fairbanks
Waterman	Fairbanks	Bulk Deliveries	Small	Fairbanks
Alaska Pure Mountain Spring Water	Juneau	5 gal	Small	Juneau
Alaskan Rain	Ketchikan	PET	Small	
Bottled Water Express	Ketchikan	5 gal	Small	Ketchikan
Purely Alaskan Water, Inc.	Palmer	PET	Large	Alaska, Lower 48
Mount McKinley Clear	Palmer	PET	Small	Alaska
Sitka Beverage Corp.	Sitka	PET	Large	Alaska, Asia, Lower 48
Alaska Tok Water	Tok	PET	Small	Tok
Choice Alaska Artesian Water	Wasilla	PET	Small	Alaska
Alaska Water Works LLC	Wasilla	Water Treatment	Small	Mat-Su Valley
Mat-Su Water	Wasilla	Water Treatment, 5 gal, Water Store	Small	Mat-Su Valley

## **Alaska Bottled Water, Export Shipments**

Alaska bottling companies have shipped containers of bottled water from two locations. Sitka Beverage Corporation packaged PET shipments for delivery, via barge and ferry, to the US west coast, including Washington and southern California. The most recent shipment was 29,000 cases purchased by Rite-Aid. Transportation costs have varied but generally average between \$0.50 and \$1.00 per case.

### **Bottled Water, Container Contents**

Bottled water is generally shipped in a standard 40-foot dry container. Cases are stacked on pallets, in six layers of 12 cases each, for a total of 72 cases per pallet. Each container can hold two rows of nine pallets each, for a total of 18 pallets. The total capacity of a container is 12 x 72 or 1,296 cases. At 24 bottles per case, a container load consists of 31,104 bottles.

A shipping quote of \$2,200 per container generates transportation costs of \$1.70 per case or \$0.071 per individual bottle, assuming a standard case size of 24 bottles.

Bottlers in Anchorage shipped several containers to southeast Asia via container from the Port of Anchorage. The most recent shipments were sent via Lykes Lines, a new shipper from Alaska.

Lykes quotes \$2,200 per container for delivery from Anchorage to Japan, direct. Shipping representatives suggest larger volumes shipped on a regular basis could generate lower quotes. One article suggests shippers could enjoy at least a 30 percent reduction in freight costs from Anchorage to Japan<sup>14</sup>.

---

<sup>14</sup> *New Asia-America ship link may open doors, save money*, Christina Session, Alaska Journal of Commerce, April 14, 2003.

Figure 10. Lykes Lines. Route Map, Anchorage to Tokyo.



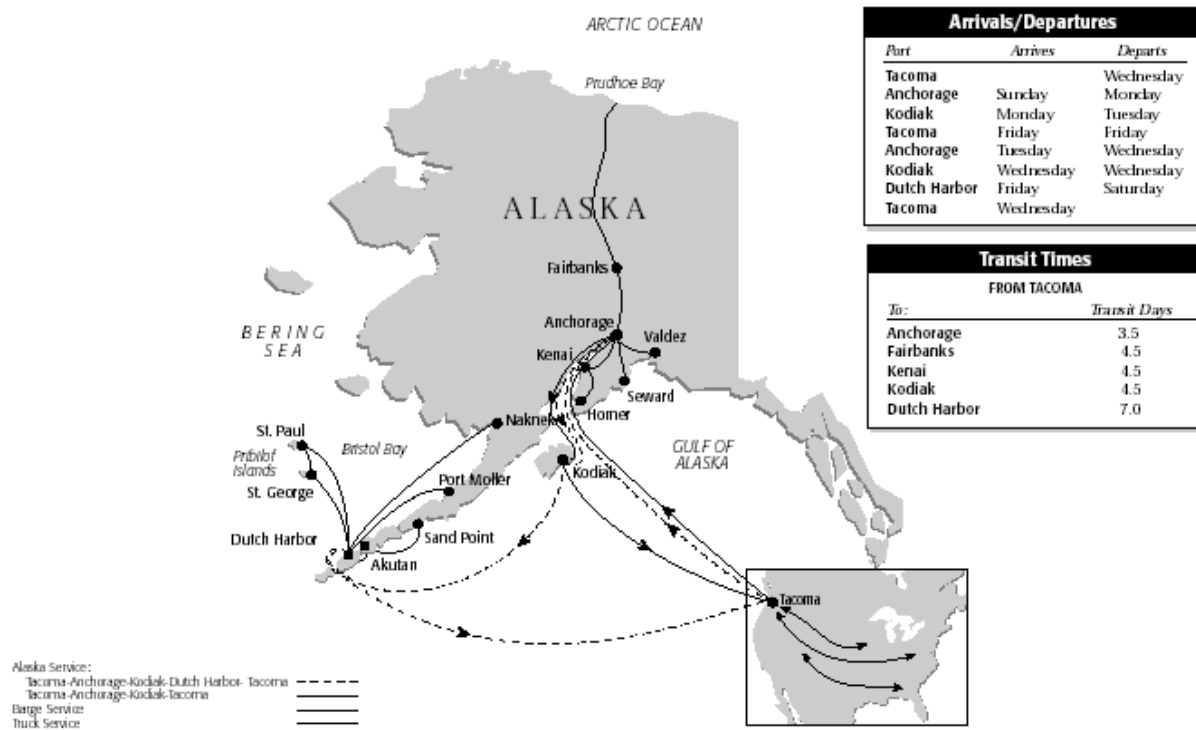
Source: <http://66.129.69.16/route.asp>, Lykes Lines.

Alternate shipping routes, from Anchorage, include Horizon Lines from Anchorage to Dutch Harbor and then Maersk from Dutch to Japan and other parts of southeast Asia.

Figure 11 illustrates shipping routes for Horizon Lines LLC to Alaska from Tacoma, and also shipping routes within the state.

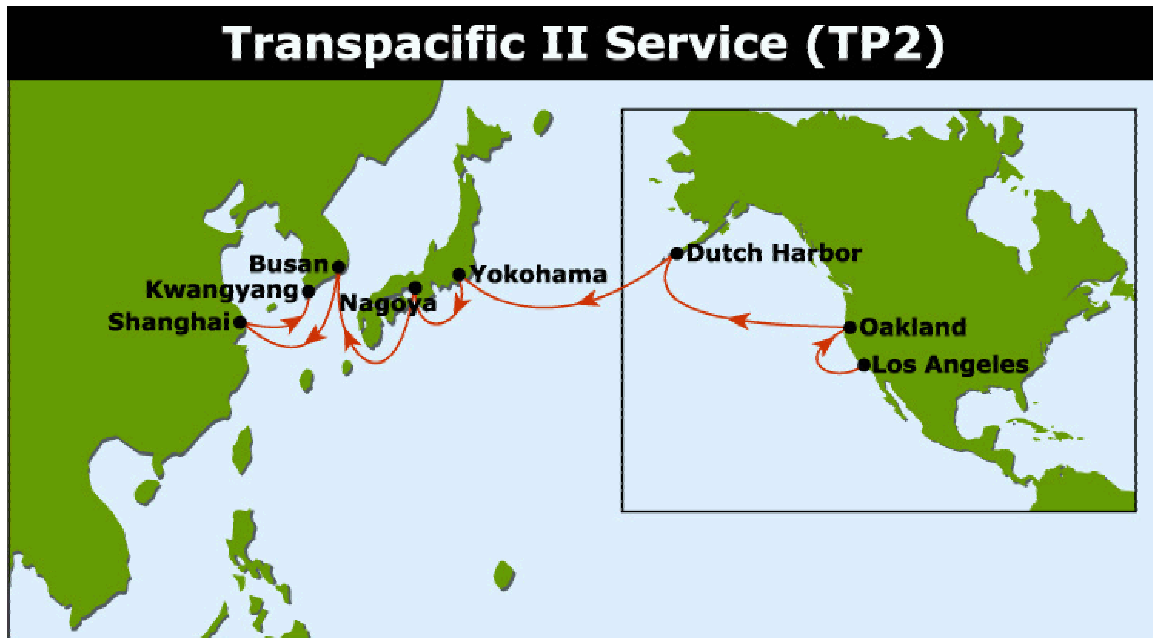
Figure 12 illustrates shipping routes for Maersk shipping lines, from Dutch Harbor to Yokohama.

Figure 11. Shipping Route, Alaska, Tacoma, Horizon Lines LLC.



Source: Horizon Lines LLC. <http://www.horizon-lines.com/alaska.asp>. December 24, 2003.

Figure 12. Maersk Shipping Route, Dutch Harbor to Yokohama



Source; [http://www.maersksealand-usa.com/advertising/sailing%20schedules/tp2\\_ib.pdf](http://www.maersksealand-usa.com/advertising/sailing%20schedules/tp2_ib.pdf)

Alternatively, containers can be shipped to the Seattle-Tacoma area via TOTE (ocean vessel) or via Lynden trucking (Alaska highway) and then transshipped to southeast Asia.

## Regulatory Framework

Export water quality—raw or food-grade—will determine which set of regulations, federal or state, will apply. Raw bulk water has the least regulatory oversight. Bottled water products are all considered food-grade and have the most regulatory oversight.

Bottled water is regulated by the federal Food and Drug Administration as a food product, while tap water is regulated by the U.S. Environmental Protection Agency and is regarded as a utility.

Water is classified as “bottled water” or “drinking water” if it meets all applicable federal and state standards, is sealed in a sanitary container and is sold for human consumption<sup>15</sup>. Bottled water cannot contain sweeteners or chemical additives (other than flavors, extracts or essences) and must be calorie-free and sugar-free. Flavors, extracts and essences—derived from spice or fruit—can be added to bottled water, but these additions must comprise less than one percent by weight of the final product.

Beverages containing more than the one-percent-by-weight flavor limit are classified as soft drinks, not bottled water. In addition, bottled water may be sodium-free or contain “very low” amounts of sodium. Some bottled waters contain natural or added carbonation.

This section provides further information about water regulations.

### Bottled Water

Bottled water is considered a food product and must meet general requirements for food labeling as contained in 21 CFR 101. This also means nutrient labeling must also be provided if the water contains nutrients or any food component<sup>16</sup>. The Food and Drug Administration's product definitions for bottled water are:

- **Artesian Water or Artesian Well Water:** Bottled water from a well that taps a confined aquifer (a water-bearing underground layer of rock or sand) in which the water level stands at some height above the top of the aquifer.
- **Drinking Water:** Drinking water is water that is sold for human consumption in sanitary containers and contains no added sweeteners or chemical additives (other than flavors, extracts or essences). It must be calorie-free and sugar-free.

---

<sup>15</sup> Adapted from references on the International Bottled Water Association, <http://www.bottledwater.org>, accessed in July 2003.

<sup>16</sup> “What guidance does FDS have for manufacturers of bottled waters?” <http://vm.cfsan.fda.gov/~dms/qa-ind4c.html>.



- **Mineral Water:** Bottled water containing not less than 250 parts per million total dissolved solids may be labeled as mineral water.
- **Purified Water:** Water that has been produced by distillation, deionization, reverse osmosis or other suitable processes and that meets the definition of purified water in the United States Pharmacopoeia may be labeled as purified bottled water.
- **Sparkling Water:** Water that after treatment and possible replacement with carbon dioxide contains the same amount of carbon dioxide that it had at emergence from the source. Soda water, seltzer water and tonic water are not considered bottled waters. They are regulated separately, may contain sugar and calories, and are considered soft drinks.
- **Spring Water:** Bottled water derived from an underground formation from which water flows naturally to the surface of the earth.
- **Well Water:** Bottled water from a hole bored, drilled or otherwise constructed in the ground which taps the water of an aquifer

The Food and Drug Administration has also published Current Good Manufacturing Practice (CGMP) Regulations for processing and bottling drinking water. CGMP regulations apply to all water within sealed containers, packages, etc. and offered for sale for human consumption. Essentially, these regulations require producers to monitor their source water, and to handle all phases of bottling and selling under safe and sanitary conditions.

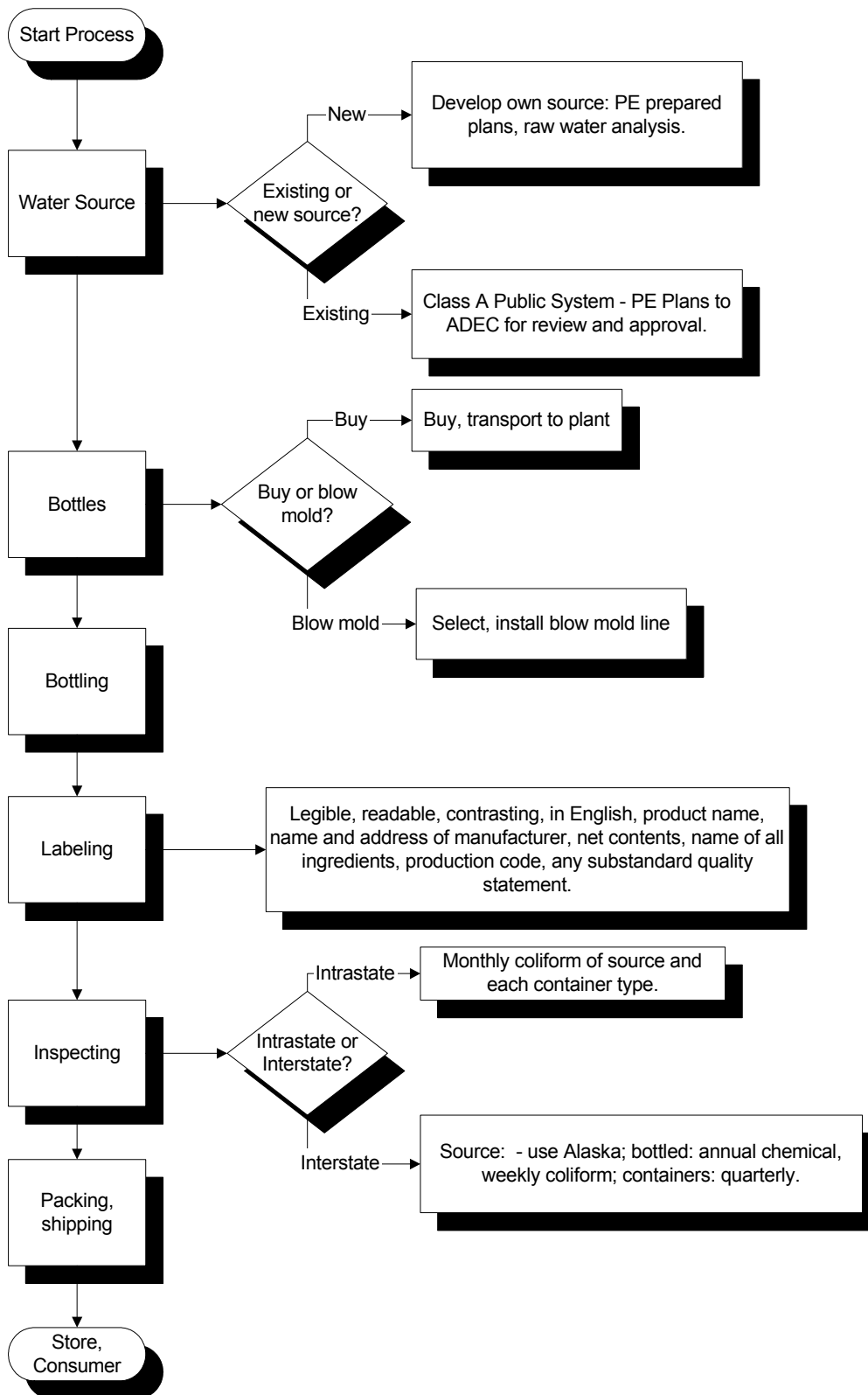
The U.S. Food and Drug Administration also regulates interstate bottlers under Title 21, Parts 129 and 165 of the Code of Federal Regulations (21 CFR, 129 & 165). It regulates intrastate bottlers who use containers shipped into Alaska.

Alaska's intrastate regulatory agencies include:

- The Department of Natural Resources, Division of Mining and Water Management: water rights, water extraction, water export
- Alaska Department of Fish and Game, Division of Sport Fish: water extraction that impacts fisheries, wildlife, or habitat
- Alaska Department of Environmental Conservation, Drinking Water Program: source, treatment and bottled water quality
- Alaska Department of Environmental Conservation, Environmental Sanitation and Food Safety: plant design, operating, microbial testing, labeling, permitting

Figure 13 illustrates regulatory oversight for Alaska water bottlers.

Figure 13. Alaska Water Bottling, Regulatory Oversight.



## Glacial Water Resource

Glacial water is a unique feature of Alaska's water supply and has been used as a marketing (branding) characteristic for several bottled water labels. As defined in 18 AAC 31.740, glacial water includes:

- Runoff directly from the natural melting of a glacier
- Water obtained from the melting of glacier ice at a permitted food processing establishment
- Stream water that flows directly from a glacier and has not been diluted or influenced by a non-glacial stream

The terms glacier-blend and glacially influenced mean water taken from:

- A glacial stream that is influenced by a non-glacial stream
- A lake that is fed by a glacial stream

Bottled water from Alaska that uses any of the above definitions may be:

- Collected and transported by pipes, tunnels, trucks or similar devices
- Not be altered at a food processing establishment; no minerals may be added or removed, but water may be filtered and otherwise treated
- Drawn from a catchment that is connected to the stream or lake water source

## Glacial Ice

Firms who wish to export processed glacial ice (not icebergs) also fall under state regulation (18 AAC 31.73). First, the facility must be permitted as a food establishment, with weekly sanitizing of food-contact surfaces and daily sanitizing of utensils.

Specific requirements for glacier ice processing include:

- Ice contamination must be minimized
- during harvest, transportation and storage
- Transport must be done in clean containers or vehicles
- Processing floors must be sloped to floor drains with traps
- Receiving and processing walls must be impervious to water up to at least four feet
- Glacial ice must be cleaned with potable water before processing

- After cleaning, belts, slides or transport equipment that can be cleaned must be used for movement into the processing area
- Manufactured ice must be separated by space or enclosure from any source of contamination
- Glacial and manufactured ice may not exceed drinking water contaminant levels

## Public Benefits

### Bulk Water Evaluation

As discussed earlier in this report, exports of raw bulk water are not cost-competitive at this time with current desalinization technology, although the political process often incorporates other measures and values in the decision making process.

While there may be a unique situation that would result in a long-term raw water export project, the financial analysis section (following) suggests a cost of \$7,900 per acre-foot (delivered to Long Beach), or \$0.0241 per gallon. If raw water were obtained at Sitka for zero cost, delivered water costs would drop to \$4,600 per acre-foot or \$0.0140 per gallon.

### Bottled Water

Bottled water plants are viable businesses in Alaska. In most instances, local Alaskan markets provide base demand and revenues. Exports, if successful, are an incremental increase in production. Bottled water that features glacier water can be a viable export business from an area such as Anchorage, with Eklutna Glacier water and Port of Anchorage container berths.

There are very large plants operating in the lower 48 states (and in other countries) that produce bottled water on a commodity basis. These plants achieve very low prices due to economies of scale and are generally low-cost producers.

As noted previously, Alaska bottled water producers will have difficulty competing on a price basis with these very large producers. The benefits discussed in this section are for water bottling plants that can achieve a unique marketing proposition and operate in niche export markets, such as bottling and distributing glacier water.

### Jobs

Jobs are one of the benefits most cited by proponents of water export facilities. The actual number of jobs can vary significantly depending on the marketing element of the plant's business model.

The three plants with the longest operating history, Alaska's Best Water (1981), Purely Alaska Water (PET bottler) (1993), and Clearly Arctic (PET bottler) (1996) employ 4-6 people in their plants and essentially have a similar business model.

All three have a domestic (local) market, but the PET bottlers export water opportunistically, using the cachet of glacier water and Alaska's image to reach foreign markets. Exports are a relatively small portion of their revenues at this time.

The plants in Hyder, Metlakatla, and Sitka have business models that are fairly similar to each other, based on marketing their products in Southeast Alaska, Canada (particularly for Hyder), and the West Coast states. An exception is the Sitka plant and its trial shipments to Rite-Aid in the Pacific Northwest and its contract with Alaska Airlines for on-board bottled water.

To date, these plants have had difficulty in successfully selling the necessary volume into these markets.

These market targets are much larger than the Southcentral Alaska market that is the primary focus of the three plants in Palmer and Anchorage. As a result, the business concepts for the three Southeast plants projected larger throughput volume and a greater number of employees than the Southcentral plants.

The plant at Sitka reportedly has 17 employees, the Hyder plant was to employ two shifts of 18 and 14 people respectively for a total of 32 but has operated only occasionally as of this date, and the Metlakatla plant could eventually employ two shifts of eight to ten people (16-20 total employment) although in late summer of 2003 the plant had four employees.

### **Taxes, Royalties, Conservation Fees**

All noted bottling plants vary in their contribution to local tax bases. For example, the Matanuska-Maid plant in Palmer (Clearly Arctic), the facility in Metlakatla, and the facility in Hyder are owned by the State of Alaska, the Metlakatla Indian Community, and the Hyder Community Association, respectively.

As facilities owned by the public or tribal and governmental entities, they are not subject to state or local taxation and may contribute little in the way of taxation or other government revenues.

Hyder does not have a local government and does not have taxing authority so local taxation is not possible. The entity formed to operate the plants could be subject to State of Alaska corporate income tax. The potential amount of corporate income tax is uncertain but anticipated to be minimal, if any.

The Purely Alaska Water plant in Palmer is subject to City sales tax, Borough property tax, and State corporate income taxes. The company leases building space but owns plant equipment. This equipment is conservatively estimated at \$2 million when new but it is uncertain what the current value of the plant would be with depreciation.

While we are uncertain of the total assessed value of the land, building, and equipment in the plant, if we assume that the total is approximately \$2.5 million, then the property taxes paid by the plant (included in rent payments), would be approximately \$33,000 per year, given the current tax rate of 13.202 mills in the Borough.

Total sales data are proprietary and the level of sales taxes Purely Alaska Water generates is unknown. While we are uncertain of the corporate structure of the company, most firms in Alaska are incorporated as Subchapter S corporations or Limited Liability Corporations in which profits are passed through to the owners. Under these corporate structures the State of Alaska does not collect any corporate income tax.

Alaska's Best Water is located in Anchorage and would be subject to the Municipality's property tax. The value of the equipment is estimated at approximately \$1.2 million and with the land and building may be approximately \$1.5 million. This valuation would generate about \$26,000 in annual property taxes for the Municipality of Anchorage. Anchorage does not have a sales tax. The corporate structure of the company is unknown and it is uncertain if the State of Alaska would collect any corporate income tax.

The value of the Sitka water plant is unknown but First National Bank of Alaska provided a loan for \$5 million to the owners of the company. Assuming a debt to equity ratio of 80:20, the total value of the facility would be about \$6 million. This would provide property tax revenues of about \$36,000 for the City and Borough of Sitka. Sitka would also receive sales tax revenues from the products that are sold. The corporate structure of the operators of the Sitka plant is unknown so it is uncertain if the plant is subject to the State of Alaska corporate income tax.

Another possible source of income to the state would be an excise tax or royalty on water used in the water plants. The City of Sitka charges 1¢ per gallon of water that is sold and 0.5¢ per gallon for water that is used for cleaning and wash down. Those amounts are likely acceptable for bottling plants but be too high for bulk, raw water exports since a 1¢ per gallon excise tax or royalty is twice as great as the cost of desalinization.

Revenues generated by such excise taxes or royalties on water use in bottling plants would not be significant revenue generators for the state. For example, the two Palmer plants use less than 1,000 gallons per day. At 1¢ per gallon, 1,000 gallons per day would generate only \$10 per day. Over the course of a year the state might receive about \$2,640, or likely less than \$5,000 from both plants. A plant using 29,000 gallons per day, such as proposed at Hyder, might generate more than \$76,000 per year but the viability of a plant at this scale has not yet been demonstrated.

Conservation fees of \$10 per acre-foot were used for costing purposes in the Financial Analysis section. This figure was derived from DNR estimates in 1994 and amounts to \$450 due to the state for each tanker-load of water shipped from Sitka.

In summary, the state is not likely to receive significant revenues from water bottling plants at this point in time.

If a bulk, raw water facility were to develop in Alaska, it would likely require a very low excise tax or royalty, approximately a few tenths of a cent, to be a viable venture.

### **Other Community Benefits**

In addition to jobs and tax revenues, bottling plants can provide other benefits to rural communities. These benefits include payments for utility services, and some portion of supplies, equipment, repairs, and transportation.

The extent of additional economic activity that would result from a bottling plant is dependent on the degree to which other services, supplies, equipment, repairs, and transportation can be met with suppliers or vendors located in the community.

In many small, rural Alaska communities a “rule of thumb” is that the multiplier effect of additional spending in the community can range from 10 percent to possibly as high as 30 percent of the original spending level. So for every dollar of sales that the bottling plant makes, the additional economic activity in the community increases by 10 to 30 percent (\$1.10 to \$1.30). Smaller communities are likely at the lower end of the range while larger communities may be higher.



## Financial Analysis

This section presents results of a financial analysis of bulk and bottled water export. A variety of sources were employed to develop the models, which were then tested to determine the sensitivity of results to changes in input values. A break-even analysis was also conducted on the bottled water model to determine the volume of sales required to be profitable.

Capital and operating costs for both bulk water and a bottled water plant of small to medium size are also discussed.

### **Bulk Water**

Capital costs for a bulk water operation, based on the Sitka to Long Beach route (estimated at 2,200 nautical miles), and a 28,000 acre feet per year annual demand, are \$350 million. This operation would require 18 single-hulled tankers and approximately 620 deliveries per year.

Annual operating and maintenance costs for this bulk water process are \$129 million with allowances for administration, engineering, permitting, and contingencies.

Delivered water cost, including the \$0.01 per gallon royalty to the City of Sitka, is \$7,900 per acre-foot. At a raw water cost of \$0.0001 per gallon, delivered water cost is projected at \$4,500 per acre-foot.

### **Cost Competitiveness, Bulk Water**

The California Department of Water Resources estimated high desalination costs (energy cost of \$0.11 per kWh) at \$1,200 per acre-foot. Adding an additional \$300 (high figure) per acre-foot of distribution costs totals \$1,500 per acre-foot for processed salt water.

The high end of desalination costs, \$1,500 per acre-foot, is approximately one-third of the low cost estimate for delivered bulk water from Sitka, \$4,500 per acre-foot.

The transactionally based cost of \$0.01 per gallon royalty to Sitka puts delivered water costs in Long Beach near \$7,900 per acre-foot.

Under the most likely scenario, it is unlikely that export bulk water from Sitka will be cost-competitive in Long Beach.

### **Bottled Water**

A bottled water plant, capable of producing and selling up to 400,000 cases per year, could generate \$1.5 million in revenue and, using industry-based figures, earnings of approximately \$110,000 before taxes.

The model was developed to reflect a reasonable entry point for a new bottled water business. Reaching full plant capacity would require a ramping-up period, estimated at three to five year, and it would depend on plant efficiency, market acceptance of the plant's bottled water, and, most likely, some percentage of export. Export could take the form of water shipped to other North American markets (Canada or the contiguous US), similar to recent sales from Sitka's bottling plant.

## **Bulk Water Capital and Operating Costs**

Estimating capital costs for bulk raw water export from Sitka to Long Beach requires an estimate of annual amounts of raw water. For this study, the annual volume of raw water was assumed to be 28,000 acre-feet based on analysis of prior projects and water plans for Southern California.

Furthermore, tanker size was assumed to be 350,000 barrels or 45.1 acre-feet. Eighteen (18) tankers would be needed to export the water.

Other assumptions included 2 days each to load and unload water, 4 days each way to travel between Sitka and Long Beach, and 20 million gallons of storage at Sitka. These storage tanks would be either large reservoirs on land or reinforced nylon bags in the water at the Sawmill Cove.

Tankers would be filled using a gravity fed pipeline at Sitka. Water would be pumped directly from the tanker into a pipeline at Long Beach, not requiring any storage facilities.

Since large oil tankers now require double hulls to transport crude oil, there are many used single-hulled tankers available for purchase between \$6 and \$10 million each. The capital cost estimate assumes \$8 million for each tanker.

To determine the cost of exporting water by tanker from Sitka to Long Beach, four annual costs were estimated. These costs include amortized capital, operating, major maintenance, and water purchase. Based on these assumptions, total capital cost for single-hulled tankers, port facilities, pipelines and other related appurtenance for exporting 28,000 acre-feet of raw water from Sitka and Long Beach is \$350 million. Assuming a 4 percent interest over 20 years, the annualized cost of \$350 million to the nearest million is \$26 million.

The operating cost per tanker per round trip is \$162,000. This unit cost includes labor, fuel, fees, overhead, insurance, and a rate of return. To meet the 28,000 acre-feet demand, 621 tanker trips would be required. Thus, the annual operating cost would be \$100.5 million. It was assumed that each tanker would be taken out of service 20 days each year for major maintenance. This annual cost is

\$1.44 million. The purchase price of raw water is also a factor, especially at the current \$0.01 per gallon figure.

These costs are summarized in the table below and are based on project research, phone calls to shippers, and other company experience.

**Table 13. Estimated Capital Costs, Bulk Water Export, 28,000 Acre-Foot Per Year, Sitka to Long Beach.**

<b>Cost, Location</b>	<b>Quantity</b>	<b>Unit</b>	<b>Unit Cost (\$)</b>	<b>Extended Total (\$)</b>
Used Single Hull Tankers	18	Each	8,000,000	144,000,000
<b>Sitka</b>				
Loading Dock for 2 Tankers	1	Lump Sum	8,200,000	8,200,000
On-Site Storage Tanks or Bags	20,000,000	Gallon	1	20,000,000
Pumping Facilities	1	Lump Sum	-	-
4' Pipeline - Sitka	2,000	Linear Foot	400	800,000
<b>Long Beach</b>				
Loading Dock for 2 Tankers	1	Lump Sum	12,000,000	12,000,000
Pumping Facilities	1	Lump Sum	5,000,000	5,000,000
4' Pipeline - Port to Water System	50,000	Linear Foot	400	20,000,000
			Subtotal:	210,000,000
Administration (%)	5			10,500,000
Engineering (%)	20			42,000,000
Permitting (%)	15			31,500,000
Contingency (%)	25			52,500,000
			Subtotal:	136,500,000
			<b>Total (rounded):</b>	<b>350,000,000</b>
Capital Cost, 20 years, 4%			Annual Cost (rounded)	26,000,000

Source: MWH.

Note: Total capital costs rounded to nearest \$5 million; annual costs rounded to nearest million.

If the cost of water is free, the cost per acre-foot is \$4,600 or \$0.014 per gallon to transport 28,000 acre-feet of raw water to Long Beach each year. If the purchase price is \$0.01 (the current contract amount) or \$0.001 per gallon, the cost per acre-foot is \$7,900 or \$5,000 respectively.

In 1992, the average cost per acre-foot for water from a brackish groundwater or seawater desalination plant was approximately \$1,400, if capital costs for the plant are amortized over 20 years (U.S. Congress, 1992). However, desalination costs have decreased the last decade due to improved technology requiring less energy to operate (California DWR, 2003).

Recent desalination costs for brackish water, using an RO process, range from \$130 to \$1,250 per acre-foot. The equivalent costs for

converting salt water to potable water are estimated at \$700 to \$1,200 per acre-foot, with an additional \$100 to \$300 per acre-foot for distribution costs (California DWR, 2003).

### **Subsea Pipeline**

For a subsea pipeline from Alaska-to-California, the cost per acre-foot for water delivered to Lake Shasta from Southeast Alaska was estimated in the \$4,000 and \$5,000 (2003 dollars) range depending on pipeline length (U.S. Congress, 1992).

It appears these are only operational costs and do not include the amortized cost of the \$150 billion conceptual cost to build the 2,000-mile pipeline.

Assuming a 14-foot diameter pipe, 4 percent interest, and 50-year life cycle, the amortized cost per acre-foot of the pipeline would be about \$1,100 more, making the range \$5,100 to \$6,100 (2003 dollars).

The projected cost of exporting bulk water by tankers is about 2.5 times the current cost of desalination and the same conceptual cost (delivered cost) as the pipeline from Sitka and Long Beach.

If the raw water cost is \$0.0015 per gallon, the unit cost of exporting water by tankers is still more than desalination but it is less than a pipeline from Sitka to Lake Shasta.

Table 14 provides more detail on estimated operating and minor maintenance costs per trip, for bulk water export from Sitka to Long Beach.

Table 15 summarizes annual bulk water export costs, delivered to Long Beach from Sitka, at \$0.0001 purchase price per gallon for raw water. This is a cost variation from the current raw water price, which is \$0.01 per gallon.

**Table 14. Estimated Operating and Minor Maintenance Costs perTrip,  
Bulk Water Export, Sitka to Long Beach.**

<b>Cost</b>	<b>Quantity</b>	<b>Unit</b>	<b>Unit Cost (\$)</b>	<b>Extended Total (\$)</b>
Operating Tanker Costs, Per Round Trip				
Load Tanker w/ Raw Water (Sitka)	2	Day	6,500	13,000
Tanker Travel (Payroll)	8	Day	7,500	60,000
Tanker Travel (Fuel)	8	Day	6,000	48,000
Tanker Travel (Other)	8	Day	500	4,000
Unload Tanker (Long Beach)	2	Day	6,500	13,000
Miscellaneous	1	Lump Sum	5,500	5,500
			Subtotal:	143,500
Administration (%)		1		718
Insurance (%)		0		359
Routine Maintenance, Repairs, Parts (%)		1		1,076
Rate of Return (%)		6		7,893
Wharfage Fee	61,248	Ton	0.08	4,600
Conservation Fee to the State of Alaska	45.0	Acre Foot	10.00	450
Contingency (%)		2		2,870
			Subtotal:	17,965
			<b>Total (rounded):</b>	<b>162,000</b>

Source: MWH

**Table 15. Summary of Annual Costs, Bulk Water Export (28,000 Acre Feet), Sitka to Long Beach.**

<b>Cost</b>	<b>Quantity</b>	<b>Unit</b>	<b>Unit Cost (\$)</b>	<b>Extended Total (\$)</b>
Major Maintenance Per Tanker Per Year				
Out of Service Maintenance	1%	Each	8,000,000	80,000
Amortized Capital	1	Lump Sum	26,000,000	26,000,000
Blue Lake (Sitka), Water Cost	14,700,000	Gallon	0.0001	1,470
Raw Water Purchase	621	Round Trip	1,470	912,383
Operations	621	Round Trip	162,000	100,548,309
Major Maintenance	18	Tanker	80,000	1,440,000
			<b>Total (rounded):</b>	<b>129,000,000</b>
			Cost Per Acre Foot (rounded):	4,700
			Cost Per Thousand Gallons	\$14.10
			Cost Per Gallon:	\$0.0141

Source: MWH.

Besides supplying needed water for southern California, mixing good quality water from Alaska with the poor quality of local water will enhance water quality water and decrease drinking water treatment costs. This will result in lower costs to the user.

## Financial Analysis, Bulk Water Export

The bulk water export analysis utilizes a model developed by MWH to determine delivered costs of raw water to Long Beach, California from Sitka, Alaska. The model utilizes the quantity of water required and the costs of delivering that water to project the cost per acre-foot in Long Beach.

A copy of the model's printout is included in Appendix C. It is based on MS Excel and is available from the Denali Commission.

The bulk water analysis assumes that Long Beach needs 28,000 acre-feet of water delivered annually. Over 620 deliveries would be made each year, requiring 18 tankers, and about 35 trips each.

Water would be purchased from the City of Sitka at \$0.01 per gallon, plus a \$10 per acre-foot conservancy fee to the State of Alaska. Taking into consideration the capital, operating, and maintenance costs, the cost to deliver to Long Beach would be \$7,900 per acre-foot, or \$0.0241 per gallon.

## Financial Analysis, Bottled Water Export

Financial statements for bottled water production and export were prepared using financial information from Risk Management Association (RMA), current public information for the Sitka Bottling Company, and input cost data from multiple sources.

Operations described by the model would operate on a single shift, and could produce up to about 400,000 cases annually with minimal capital investments. The model has been developed this way to reflect a reasonable entry point for a new bottled water business.

The bottled water analysis assumes that the business has about \$2.2 million in total assets, including \$500,000 of bottling and packaging equipment, a 2,000 square foot building valued at \$250,000, and \$35,000 in office and delivery equipment.

Five people are employed to cover all aspects of production, marketing, and administration. The business produces 300,000 cases of water annually, at a cost of \$2.67 per case, and sells each case for \$5.00 wholesale. Under these assumptions, the business has revenues of \$1.5 million.

Table 16 shows the pro forma income statement for this model operation, along with RMA benchmarks.

**Table 16. Bottled Water Pro Forma Income Statement**

	Dollars	% of Revenue	RMA Benchmark (%)
Revenues	1,500,000	100.00	
Cost of Goods Sold. Includes:	991,324	66.09	
<i>Raw Materials Cost</i>	801,524	53.43	
<i>Direct Labor Cost</i>	189,800	12.65	
Gross Profit Margin	508,676	33.91	51.10
Operating Expenses	281,200	18.75	44.80
Selling	112,500	7.50	
General and Administrative. Includes:	146,200	9.75	
<i>Indirect Labor Costs</i>	96,200	6.41	
<i>Building and Utilities</i>	50,000	3.33	
Other Operating Expenses	22,500	1.50	
Operating Profit	227,476	15.17	6.30
All Other Expenses (net)	117,750	7.85	1.30
Income Before Taxes	109,726	7.32	5.00

The cost of goods sold is approximately two-thirds of total revenue. Operating and other non-operating expenses account for another 27 percent of the revenue.

Compared with RMA income statement information for an operation with \$2 million in assets, this model would be slightly more profitable than average, with a 7.3 percent profit margin before taxes, versus the national average of 5 percent.

The gross profit margin would be smaller than RMA averages (34 percent versus 51 percent), but the operating profit margin would be larger (15 percent versus 6 percent).

This conceptual model ignores the financial transitions from a start-up company to one that is in full production, a transition that may take up to five years, depending on markets, technology, and management.

## **Sensitivity Analysis**

A sensitivity analysis was conducted on both the bulk water cost model and the bottled water pro forma income statement.

The analysis was conducted using Crystal Ball software, termed an *add-in* for Microsoft Excel. Crystal Ball uses Monte Carlo analysis, allowing users to track output estimates (revenue or price) as input values (costs) fluctuate according to defined probability distributions. Both analyses for this study used 10,000 trials.

### **Bulk Water Sensitivity**

The purpose of the bulk water sensitivity analysis was to determine the likely range of acre-foot cost for water delivered to Long Beach, California for Sitka, Alaska. The analysis allowed variation in the quantity of water demanded, as well as capital and investment costs. All variations were plus or minus 35 percent.

The original cost model rounded the final and many intermediate calculations. For the sensitivity analysis, those restrictions were relaxed to allow a full range of variation in acre-foot costs. As mentioned above, the estimated cost per acre-foot is \$7,900.

The sensitivity analysis indicated a delivered cost range of \$6,750 to \$8,818 per acre-foot. The mean cost was \$7,803 and the median was \$7,802.

The largest variations in acre-foot cost are caused by payroll and fuel costs for tanker operations, and the purchase price for each tanker. The effects of other changes are relatively small. Table 17 shows the cost per acre-foot for each ten-percent decile.



**Table 17. Bulk Water Cost per Acre-Foot by Decile**

Decile (%)	Cost per Acre-Foot (\$)
0	6,750
10	7,424
20	7,552
30	7,650
40	7,729
50	7,802
60	7,880
70	7,961
80	8,052
90	8,182
100	8,818

Changes in major factors—fuel costs, payroll costs, and tanker price—do **not** produce significant changes in the cost per acre-foot.

Increasing or decreasing payroll cost by 50 percent only changes delivered water cost by about 9 percent. Fuel cost changes of 50 percent generate a 7.4 percent change in acre-foot cost.

Changes in tanker purchase costs are likewise small. A 50 percent change in tanker price only causes a 4.3 percent change in the cost per acre-foot.

This analysis has shown that the cost per acre-foot delivered to Long Beach, California is insensitive to most cost variations. Larger or faster tankers may affect the transportation cost, but for the most part delivered cost per acre-foot cost varies little.

As a result, the success of water export depends on the target market's cost per acre-foot using available transportation, treatment, and competing desalinization technology.

### **Bottled Water Sensitivity Analysis**

The purpose of the bottled water sensitivity analysis was to determine the likely profit range (measured before taxes) under an expected range of operating conditions.

The analysis included variations in the input costs (perform bottles, caps, labels, case packing, and water), production levels, and wholesale price per case. Table 18 shows low, likely, and high price assumptions for raw materials.

**Table 18. Bottled Water Raw Material Price Assumptions**

Input	Per Unit Price (\$)		
	Low	Likeliest	High
Preform bottles	0.050	0.060	0.100
Caps	0.009	0.010	0.015
Label	0.010	0.015	0.030
Water	0.001	0.010	0.020
Case Packing	0.300	0.600	0.650
Total per Bottle	0.069	0.085	0.145
Total per Case	1.956	2.640	4.130

Production levels were allowed to vary from 200,000 cases annually to 400,000, with 300,000 being the most likely. Wholesale price per case was allowed to vary from \$4.50 to \$5.50, with \$5.00 being the most likely.

The sensitivity analysis showed a before-tax range of a loss of \$324,000 to a profit of \$508,000. The mean profit was \$28,000 and the median was \$23,000. Table 19 shows the profit for each decile. The table shows that there is a probability of between 50 and 60 percent that the operation described by the financial model would realize a profit before taxes.

**Table 19. Bottled Water Profit Before Taxes by Decile**

Decile (%)	Profit Before Taxes (\$)
0	-324,189
10	-129,135
20	-77,339
30	-42,572
40	-9,948
50	23,229
60	56,265
70	90,801
80	133,700
90	193,303
100	507,530

This analysis has shown that the probability of success is relatively low for the operation described by this simple financial model.

Further refinements to the model and its assumptions would yield a more accurate evaluation. Recommended refinements include adjusting capital costs to fit the range of production capabilities and local prices and determining likely funding and financing options that will affect the new operation's financial burden.

As note earlier, there are significant variations in costs and revenues when comparing a start-up company with on-going operations. These have to be carefully evaluated for each specific case.

## **Break-even Analysis**

A simple break-even analysis was conducted using the bottled water pro forma income statement. Two analyses were conducted: one for production levels and one for the wholesale price per case.

Using input cost data from a number of sources and an estimated wholesale price of \$5 per case, the analysis showed a break-even annual production of 242,000 cases, or just over 20,000 cases per month.

Wholesale price per case has the largest impact on the break-even quantity. If the business were only able to sell cases for \$4 wholesale, the break-even quantity would nearly double to 470,000 cases, or 39,000 cases per month.

The second analysis looked at the wholesale price per case needed to break even at specific production levels. With 300,000 cases produced annually, the break-even wholesale price per case is about \$4.60. This price drops to \$4.18 with a production of 400,000 cases, and increases to \$5.43 with a production of 200,000 cases.

## Summary, Market Opportunities

Market opportunities for bulk and bottled water operations within Alaska have significantly different profiles. They are discussed in the following subsections.

### Alaska Bulk Water Export Potential

Alaska's bulk water, especially from Sitka's Blue Lake, is very clean, with low dissolved solids and is generally free of pesticides, fertilizers, and other industrial and agricultural by-products found in other parts of the world.

The high quality of this raw water makes it very attractive for blending and diluting with other water such as that from southern California.

There is a plentiful supply in most coastal Alaska areas, with Sitka, Anchorage, and Adak representative of several sources.

Cost is the major hurdle to bulk water export. Both capital costs and operating costs are higher than the competing technology, desalination, except in very limited circumstances.

Capital costs for tanker purchases, or pipeline design and construction, are relatively high and unlikely to decline. Operating and maintenance costs for bulk water transfer are equally high, whether tanker-based or related to pumping through a pipeline. The long-term trend for these costs is a gradual increase, due to labor and fuel.

Desalination is the major competitor for Alaska's bulk water and the long-term trend for this technology is a decline in both capital and operating costs. New technologies are being developed as forecasts through 2025 suggest water shortages will continue in most areas, and increase in others.

### Alaska Bottled Water Export Potential

Bottled water consumption is growing rapidly throughout the world, with a projected 8 to 10 percent per year rate. Alaska has quality water in considerable supply, including a relatively unique product in the form of glacial water.

Bottling firms are located near tidewater, from Sitka to Anchorage, and they have considerable access to export markets via containerized shipping. Asia has shown strong interest in bottled water (PET) from Alaska, especially with a glacial connection, image, or state certification.

Local markets are more limited and there is strong cost competition from other bottlers, including low-cost producers in the lower 48

states. As bottled water continues to be commodified, local bottling firms will have to become more cost efficient, which generally means more capital investment (automation). However, it is unlikely local bottling firms can achieve efficiencies of sale enjoyed by large bottling firms such as Pepsi and Coca-cola.

Environmental concerns are low at this time, but future concerns are likely to include solid waste aspects of PET containers.

## Appendices

A – References

B – Conversion Factors

C – Bulk (Raw) Water Tanker Export—Sitka, AK to Long Beach, CA

## Appendix A—References

- 10th Annual Southern California Urban Water Conference. Urban Water Institute. 2003. [www.urbanwater.com/index.html](http://www.urbanwater.com/index.html).
- 1999 CFR Title 40, Volume 15 Protection of Environment. CFR. 1999. [www.access.gpo.gov/nara/cfr/waisidx\\_99/40cfr141\\_99.html](http://www.access.gpo.gov/nara/cfr/waisidx_99/40cfr141_99.html).
- 2002 NAICS Definitions. U.S. Census Bureau. 2002.
- 464 Brands Soft Drink-Weights & Measures. 464 Brands Limited. United Kingdom. 2003. [www.464.co.uk](http://www.464.co.uk).
- Ackerman, Lisa; Bannon, Jeff; Leophairatana, Achira; Yamada, Kaz. Assessment of Seawater Desalination as a Water Supply Strategy for San Diego County. University of California Sanata Barbara. 2003.
- Alaska Department of Natural Resources (DNR). 1994. Water Exports. Alaska Hydrologic Survey.
- Alaska Division of Water. Alaska Department of Natural Resources. 1990.
- Alaska Glacier Refreshments. 2003. [www.alaskaglacier.com](http://www.alaskaglacier.com).
- Alaska Issues First Water-Export Permit. AWWA Journal. 1997.
- Alaska Rural Water Association. 2003.
- Alaska Surface-Water Resources. U.S. Geological Survey.
- Alaska Water Professionals Training Conference. Alaska Rural Water Association. 2003. [http://www.arwa.org/p\\_download.html](http://www.arwa.org/p_download.html).
- Alaskan Water for California?: The Sub sea Pipeline Option. Congress of the United State Office of Technology Assessment. 1992.
- Alaska's Abundant Water Tempts a Thirsty World. Seattle Post-Intelligencer. 2002. [www.seattlepi.com](http://www.seattlepi.com).
- Alaska's Best Water. 2000. <http://home.gci.net/~alaskasbestwater/default/htm>.
- Aleut Enterprise Corporation. Application for Water Right, Lake Betty, Lake Bonnie Rose, Lake DeMarie. Alaska Department of Natural Resources. 1999.
- All About... Glaciers. NSIDC. 2003.
- American Water Resources Association Bibliography for Alaska. American Water Resources Association. 2003. [www.awra.org/jawra/geographic/geogalaska.html](http://www.awra.org/jawra/geographic/geogalaska.html).
- Anchorage Water and Wastewater Utility Annual Water Quality Report 2003. Anchorage Water and Wastewater Utility. 2003.

- Anchorage's Water Voted Best Tasting In the USA by United States Conference of Mayors. AWWU. 2003.  
[www.awwu.ci.anchorage.ak.us/website/Water/bestw.htm](http://www.awwu.ci.anchorage.ak.us/website/Water/bestw.htm).
- Anderson, John. Desalination: Is It worth Its Salt?. NSW Department of Commerce. Australia. 2003.
- Anderson, Terry J.; Landry, Clay J. Exporting Water to the World. Hoover Institution.
- Aquastat. FAO. 2003. [www.fao.org/ag/agl/aglw/aquastat/](http://www.fao.org/ag/agl/aglw/aquastat/).
- Arab Thought Forum. Domestic Energy Policies in the Arab World Linkages with the Water Sector. National Press. Jordan. 2002.
- Ariyork, Ayca. Turkish Water to Israel?. The Washington Institute for Near East Policy. Isreal. 2003.  
[www.washingtoninstitute.org/watch/Policywatch2003/782](http://www.washingtoninstitute.org/watch/Policywatch2003/782).
- Asad, Musa; Azevedo, Luiz Gabriel; Kemper, Karin E.; Simpson, Larry D. Management of Water Resources Bulk Pricing in Brazil. The World Bank. 1999.
- Australia Broadens Attack On Global Farm Subsidies. The Wall Street Journal. Australia. 2003. [www.wsj.com](http://www.wsj.com).
- Ballina Shire Urban Water Management Strategy Options Study Working Paper Analysis of Desalination Options. Ballina Shire Council. Australia. 2003.
- Benke, Richard. Aquifer Near Alamogordo Could Be Possible Water Source. Santa Fe New Mexican. 2003.  
[www.rioweb.org/Archive/jss3-wbr071203.html](http://www.rioweb.org/Archive/jss3-wbr071203.html).
- Best Practices in PET Recycling. American Plastics Council. 2003.
- Bicak, Hasan Ali; Jenkins, Glenn P. Costs and Pricing Policies Related to Transporting Water by Tanker from Turkey to North Cyprus. Harvard Institute for International Development. Turkey. 1999.
- Blake, Judith. Study: Extra Oxygen doesn't make bottled water healthier. The Seattle Times. 2003.
- Blue Gold: The Battle Against Corporate Theft of the World's Water. Polaris Institute. 2003.
- Blumenthal, Ralph. West Texans Sizzle Over a Plan to Sell Their Water. The New York Times. 2003.
- Bottled Water Web. 2003. [www.bottledwaterweb.com](http://www.bottledwaterweb.com).
- Bottling Alaska's Water Questions and Answers. Alaska DEC. 2000.  
[www.state.ak.us/dec/sanitat/bottled.htm](http://www.state.ak.us/dec/sanitat/bottled.htm).
- Box Trotters. 2003. [www.boxtrotters.com/EquipementSelection.htm](http://www.boxtrotters.com/EquipementSelection.htm).
- Builder of Tampa Bay Desalination Plant Files for Bankruptcy. Tallahassee.com. 2003.



- Bulk Water Removal and Water Export. Environment Canada. Canada. 2003.  
[www.ec.gc.ca/water/en/manage/removal/e\\_remove.htm](http://www.ec.gc.ca/water/en/manage/removal/e_remove.htm).
- Buros, O.K.; American Desalting Association; National Water Research. Desalting As An Environmentally Friendly Water Treatment Process. U.S. Department of the Interior Bureau of Reclamation Denver Office Technical Service Center. 1994.
- Caldwell, Jay. Forget Fancy Water; Get Your Oxygen by Breathing. Anchorage Daily News. 2003. [www.adn.com](http://www.adn.com).
- California Department of Water Resources (California DWR). 2003. Water Desalination – Findings and Recommendations. October.
- California Department of Water Resources, Bay-Delta Office Modeling Support Branch. California Department of Water Resources Bay-Delta Office Modeling Support Branch. California Department of Water Resources Bay-Delta Office. 2002. <http://modeling.water.ca.gov>.
- California Skeptical of water Idea. The Alaska Journal of Commerce. 2003. [www.alaskajournal.com](http://www.alaskajournal.com).
- California Water Desalination Task Force Final Report. California Water Desalination Task Force. 2003.
- California Water Desalination Task Force Desalination Technology Working Paper. California Water Desalination Task Force. 2003.
- California Water Plan Draft Assumptions & Estimates. California Water Plan. 2003.  
[www.waterplan.water.ca.gov/AandE/Pages](http://www.waterplan.water.ca.gov/AandE/Pages).
- California Water Plan Update 2003. California Department of Water Resources. 2003.
- Camdessus, Michel; Winpenny, James. Financing Water for All. World Water Council. 2003.
- Carbonated soft drinks and beverage milk. USDA. 2003.  
[www.ers.usda.gov/octemp/rad60AEA.jpg](http://www.ers.usda.gov/octemp/rad60AEA.jpg).
- Carlsbad Desalination Project Fact Sheet. Poseidon Resources. 2003.
- Central Intelligence Agency. The World Fact book 2003. Brassey's, Inc. 2002.
- Chaudhry, Shahid. Unit Cost of Desalination. California Energy Commission.
- CIMIS Agriculture Resource Book. California Irrigation Management Information System. 2000.
- CIMIS References. CIMIS. 2003. [www.cimis.water.ca.gov](http://www.cimis.water.ca.gov).

- City & Borough of Sitka, Alaska (Sitka). 2003. Request for Proposal and Interest – Bulk Water Sales. Website: [www.sawmillcove.com](http://www.sawmillcove.com).
- City and Borough of Sitka Water and Waste Water 2001 Watershed Control Report. City of Sitka. 2002. <http://www.cityofsitka.com/watershed/watershed.htm>.
- City and Borough of Sitka Water and Waste Water Drinking Quality Report for the Year 2002. City of Sitka. 2003. <http://www.cityofsitka.com/confidence/confprt02.htm>.
- Cody, Beth A. Western Water Resource Issues. The National Council for Science and the Environment. 2001.
- Cohen, Amiram. Water Desalination Costs on the Decline. Bar-Ilan University. Israel. 2002. [www.biu.ac.il/Spokesman/Stories/jan\\_03\\_2002\\_eng.htm](http://www.biu.ac.il/Spokesman/Stories/jan_03_2002_eng.htm).
- Conaughton, Gig. Water Officials: The Sea is the Future. North County Times. 2003. [www.nctimes.net/news/2003/20030110/52409.html](http://www.nctimes.net/news/2003/20030110/52409.html).
- Container Equipment Available. Port of Halifax. Canada. 2003. [www.portofhalifax.ca./contain2.htm](http://www.portofhalifax.ca./contain2.htm).
- Container Specification. CNPedia. 2003. [www.cnpedia.com/pages/knowledge/boxsize4.htm](http://www.cnpedia.com/pages/knowledge/boxsize4.htm).
- Cortese, Amy. Business; They Care About the World (and They Shop, Too). The New York Times. 2003.
- Cowett, C. Michael; Brenneman, Reagan L. Desalination Another Solution to our Water Supply Crisis. The San Diego Union-Tribune; [www.poseidonhb.com/news/news02.html](http://www.poseidonhb.com/news/news02.html). 2002.
- Dabbs, Paul. California Water Plan Update 2003 Information. California Water Plan. 2003.
- Davidge withdraws water bag applications!. Friends of Gualala River. 2002. [www.gualalariver.org/export/default.html](http://www.gualalariver.org/export/default.html).
- Davidge, Ric. Alaska Water Exports. Alaska Department of Natural Resources. 1994.
- Davis, T. Neil. Exporting Water Article #284. University of Alaska Fairbanks. 1979.
- Department of Environmental Conservation Water Quality Standards. Alaska Department of Environmental Conservation. 2003.
- Desalting Facts. American Membrane Technology Association. 2003. [www.membranes-amta.org/desalting.html](http://www.membranes-amta.org/desalting.html).
- Diagram of the Water Cycle. USGS. 2003. <http://ga.water.usgs.gov/edu/watercyclegraphichi.htm>.

- Division of Mining, Land & Water Alaska Department of Natural Resources. Fact Sheet Water Rights in Alaska. Alaska Department of Natural Resources. 2003.
- Donovan, Larry. Water Bag Technology. University of Alberta ORG 436. Canada.
- Downloads and Resource Center Report Series. SIWI. 2003.  
<http://www.sivi.org/downloads/downreport.html>.
- Earth's Water Distribution. USGS. 2003.  
<http://ga.usgs.gov/edu/waterdistribution.html>.
- East Asia & Pacific Overview. Water and Sanitation Program. 2003.
- Eckholm, Eric. A River Diverted, the Sea Rushes In. New York Times. Pakistan. 2003.
- Elliott, Stuart. The Media Business: Advertising; Coca-Cola tries selling sexiness in promoting Dasani in the competitive bottled water market. New York Times. 2003.
- Ending California's Water Crisis: A Market Solution to the Politics of Water. 2003.  
[www.pacificresearch.org/pub/sab/enviro/watermkts/main.html](http://www.pacificresearch.org/pub/sab/enviro/watermkts/main.html).
- Ending California's Water Crisis: A Market Solution to the Politics of Water. Pacific Research. 2003.  
[www.pacificresearch.org/pub/sab/enviro/watermkts/main.html](http://www.pacificresearch.org/pub/sab/enviro/watermkts/main.html).
- Export of Water from Norway. Norweigan Institute for Water Research. Norway. 1995. [www.niva.no](http://www.niva.no).
- Fact Sheets. American Water Works Association. 2003.  
[www.awwa.org/Advocacy/pressroom/Desalination.cfm](http://www.awwa.org/Advocacy/pressroom/Desalination.cfm).
- Factiva.com. Turkey and Israel Agrees on Water Transportation. Israeli Energy Minister Joseph Paritzsky.... Israel. 2003.  
<http://integrate.factiva.com/search/article.asp?>.
- Fallbrook Public Utility District Candidate Questions Lou Ballou. Luther Ballou. 2003.  
[www.rhscomputers.com/louballou/question1.html](http://www.rhscomputers.com/louballou/question1.html).
- Farwell to Alaska. Pravda. Russia. 2003.
- Figure in California Water Plan Update 2003. 2003.  
[www.waterplan.water.ca.gov](http://www.waterplan.water.ca.gov).
- Formation of Medusa Water International. Medua Water Internationals Ltd. United Kingdom. 2000.
- Frequently Asked Questions. Metropolitan Water District of Southern California. 2003. [www.mwd.dst.ca.us/](http://www.mwd.dst.ca.us/).
- Freshwater Resources. FAO. 2002.  
[www.fao.org/waicent/faoinfo/agricult/agl/aglw/aquastat/water\\_res/index.stm](http://www.fao.org/waicent/faoinfo/agricult/agl/aglw/aquastat/water_res/index.stm).

- Gallagher, David F. Going Backwards 'Just Say No to H2O' (Unless It's Coke's Own Brew). The New York Times. 2001.  
[www.commondreams.org/headlines01/0902-01.htm](http://www.commondreams.org/headlines01/0902-01.htm).
- Garn, Mike. Managing Water as an Economic Good. The World Bank.
- Gleick, Peter H.; Wolff, Gary; Chalecki, Elizabeth L.; Reyes, Rachel. The New Economy of Water. Pacific Institute. 2002.
- Gleick, Peter. The Human Right to Water. Pacific Institute for Studies in Development, Environment, and Security. 1999.
- Gleick, Peter. Basic Water Requirements for Human Activities: Meeting Basic Needs. Water International. 1996.
- Global H2O. Global H2O. 2003.  
[www.gh2otogo.com/executive.html](http://www.gh2otogo.com/executive.html).
- Global Water Supply and Sanitation Assessment 2000 Report. World Health Organization; UNICEF. 2000.
- Golder Associates. Water Resources-Project Highlights Watershed Planning in Kodiak. Golder Associates. 2003.
- Goodnough, Abby. Developers Urge Support of Water Transfer to Populous South Florida. The New York Times. 2003.  
[www.nytimes.com/2003/09/27/national/27WATE.html?](http://www.nytimes.com/2003/09/27/national/27WATE.html?).
- Google Question De-salinating Water. Google.com. 2003.
- Grant, Drew. Alaska 1998 305 (b) Report. Alaska Department of Environmental Conservation. 1998.
- Ground Water's Role in Alaska's Economic Vitality. National Ground Water Association. [www.ngwa.com](http://www.ngwa.com).
- Hanbury, W.T.. Trends in Desalination Technology. Prthan Ltd. United Kingdom.
- Hayes, David. Privatization and Control of U.S. Water Supplies. American Bar Association. 2003.
- Hearne, Robert R.; Easter. K. William. Water Allocation and Water Markets. World Bank. 1995.
- Hemmelgarn, Melinda. Nutrinomics-Demographics and Food Consumption Trends. University of Missouri-Columbia. 2003.  
<http://outrach.missouri.edu/hestrnutrnews/nutrinomics8-8-02.htm>.
- Henry, Tom. Water: The Coming Crisis Story. SEJournal. 2001.
- Holm, Wendy R. Popular Myths Concerning Water and the NAFTA. Canada. 2003. [www.farmertofarmer.com.ca/MYTHS.html](http://www.farmertofarmer.com.ca/MYTHS.html).
- Horizon Lines Alaska Service October-December 2003. Horizon Lines. 2003. [www.horizonlines.com](http://www.horizonlines.com).

- How Much Does Desalted Water Cost?. American Membrane Technology Association. 2001.
- How Much is Inside 40 Foot Shipping Container?. 2003. [www.cockeyed.com/inside/container/container.html](http://www.cockeyed.com/inside/container/container.html).
- How Much Water is There on (and in) the Earth?. USGS. 2003. <http://ga.water.usgs.gov/edu/earthhowmuch.html>.
- Imperial Irrigation District, IID: Water. Imperial Irrigation District. 2003. [www.iid.com](http://www.iid.com).
- Inbar, Efraim. A Drop in the Ocean. Jerusalem Post. Isreal. 2003. <http://pqasb.pqarchiver.com/jpost>.
- Indicators on water supply and sanitation. United Nations Statistics Division. 2003. <http://unstats.un.org/unsd/demographic/social/watsan.htm>.
- Interactive Units Converter. Convert-me.com. 2003.
- International Water Resources Association. 2003. <http://iwra.siu.edu>.
- Irrigation Management. University of California Cooperative Extension. 2003. [http://ceimperial.ucdavis.edu/Custom\\_Program275/Irri](http://ceimperial.ucdavis.edu/Custom_Program275/Irri).
- Israel-Turkey Economics. Israel Buys Turkish Water. Isreal. 2003. [www.arabicnews.com](http://www.arabicnews.com).
- Japan Bottled Water Market: Growing Fast With Per Cap Consumption Far Behind U.S. and Europe. Beverage Digest. Japan. 2002. [www.beverage-digest.com/editorial/021004.php](http://www.beverage-digest.com/editorial/021004.php).
- Jellinek, Sergio. World Bank Endorses Water Resources Strategy. The World Bank. 2003.
- Johnson, Neil. Patience Runs Thin Amid Desalation Plant Failures. The Tampa Tribune. 2003. [www.trampatrib.com/floridametroneews](http://www.trampatrib.com/floridametroneews).
- Kahdim, Abdul Sattar; Ismail, Saleh; Jassim, Alaa' Abdulrazaq. Modeling of Reverse Osmosis Systems. Elsevier Science B.V. Iraq. 2003.
- Kathe Tanner. Desalination has the votes in Cambria. The Tribune. 2003. [www.sanluisobispo.com/](http://www.sanluisobispo.com/).
- Keinon, Herb. Deal to Buy Water from Turkey Finalized. Jerusalem Post. Isreal. 2003. <http://pqasb.pqarchiver.com/jpost>.
- Kilgannon, Corey. Brita Will Pull Ad Mocking City Water. The New York Times. 2003.
- Labeledz, Gordon. Seawater Desalination Plants. The Surfrider Foundation. 1994. [www.surfrider.org/desal/htm](http://www.surfrider.org/desal/htm).

- Laing, Yehezkel. Dor Backs out of Haifa Desalination Plant Project. Jerusalem Post. Israel. 2003.  
<http://pqasb.pqarchiver.com/jpost>.
- Lokiec, Fredi; Kronenberg. Emerging Role of BOOT Desalination Projects. IDE Technologies, LTD. Israel. 2000.
- Lykes Lines On-line. Lykes Lines. 2003. [www.lykeslines.com](http://www.lykeslines.com).
- Maersk Company Profile. Maersk Inc. 2003.
- Markell, Joanna. Hyder in Water Business. Alaska Journal of Commerce. 2001.
- Mary Lynne Dahl. Metlakatla Indian Community Metlakatla, Alaska Bottled Water Project. Metlakatla Indian Community. 2003.
- McCann, B. 2000. The Ocean Solution.  
[www.cix.co.uk/~salvage/medusabag/the\\_ocean\\_solution.htm](http://www.cix.co.uk/~salvage/medusabag/the_ocean_solution.htm).
- Mehmet, Ozay. Water Balances in the Eastern Mediterranean. International Development Research Centre. Canada. 1998.  
[www.idrc.ca/books/fpcus/907/ackn.html](http://www.idrc.ca/books/fpcus/907/ackn.html).
- Metlakatla Bottled Water Company, Alaska. Metlakatla Bottled Water Company.
- Metlakatla Bottled-Water Plant Launched. Juneau Empire. 2003.
- Metlakatla Indian Community. 24 CFR Part 50 Environmental Reviews Pursuant to Section 1000.20. Ray Bloom, R&M Engineering-Ketchikan. 2002.
- Ministerial Committee Examining the Export of Bulk Water. Export of Bulk Water from Newfoundland and Labrador. Government of Newfoundland and Labrador. Canada. 2001.
- Misty Fjords Alaska Natural Artesian Water. Misty Fjords Water Co. 2003.
- Moss, Jack; Wolff, Gary; Gladden, Graham; Gutierrez, Eric. Resume of the "white" Paper on Valuing Water for Better Governance. CEO Panel. 2003.
- National Water Summary. Alaska Water Use and Supply. USGS. 1987.
- Nestle to Set Up Shop IN Iraq; Undecided on Iran Growth. Wall Street Journal. Iraq. 2003.
- New Desalination Process Cuts Cost: New Scientist. The Sydney Morning Herald. Australia. 2003. [www.smh.com.au](http://www.smh.com.au).
- Newfoundland and Labrador Water Export. Progressive Conservative Party of Newfoundland & Labrador. Canada. 2003.  
[www.pcparty.nf.net/water.htm](http://www.pcparty.nf.net/water.htm).

- NRS Consulting Engineers. Desalination/Water Supply & Systems/ Planning & Project Management. NRS Consulting Engineers. 2003.  
[www.nrsengineers.com/printerpages/southmost\\_print.htm](http://www.nrsengineers.com/printerpages/southmost_print.htm).
- NWBWA Bottlers. Northwest Bottled Water Association. 2003.  
<http://uniqueapp.com/nwbwademo/bottlers.php>.
- Ocean Container Dimension. Bruning International Corportation. 2003. <http://bruninginternational.com>.
- Ocean Container Dimension. Foreign Trade Online. 2003.  
[www.foreign-trade.com/reference/ocean.cfm](http://www.foreign-trade.com/reference/ocean.cfm).
- Ocean Rate Bulletin. USDA. 2003. [www.ams.usda.gov/tmd/ocean](http://www.ams.usda.gov/tmd/ocean).
- Ocean Shipping Container Capacities. Alken Murray Corp.  
[www.alken-murray.com](http://www.alken-murray.com).
- Olson, Elizabeth. Water in Tap Beats Bottled, Group Says. The New York Times. 2001.
- Orange County Desalination Project. Poseidon Resources. 2002.
- Order Acknowledging Effective Date of Tariff Revision; Imposing Stipulated Conditions; Granting Waiver; and Approving Tariff Sheets. State of Alaska The Alaska Pulic Utilities Commission. 1998.
- Order Suspending Tariff Revision; Initiating Investigation; Designating A Subset of Commission Staff a Party; Establishing Hearing and Filing Schedule; and Appointing a Hearing Officer. State of Alaska The Alaska Pulic Utilities Commission. 1997.
- Pacific Institute Water and Climate Bibliography. Pacific Institute. 2003.
- Pamukcu, Konuralp. Water-Related Cooperation Between Turkey and Israel. Turkish Studies Institute. Turkey. 2003.  
<http://tsi.idc.ac.il/pamukcu.html>.
- Payne, Paul. Davis signs bill to scuttle water export. Public Citizen. 2002. [www.citizen.org/hot\\_issues/](http://www.citizen.org/hot_issues/).
- Perry, C.J.; Rock, Michael; Seckler, D. Water as an Economic Good: A Solution, or a Problem?. International Irrigation Management Institute. Sri Lanka. 1997.
- Petcore Frequently Asked Questions. Petcore. Europe. 2003.  
[www.petcore.org/faq\\_01.html](http://www.petcore.org/faq_01.html).
- Petcore Processing. petcore. Europe. 2003.  
[www.petcore.org/envir\\_proc\\_01.html](http://www.petcore.org/envir_proc_01.html).
- Peter Gleick et al. The World's Water The Biennial Report on Freshwater Resources 2002-2003. Washington Press. 2002.

- Pierce, Richard A. Russia in North America Proceedings of the 2nd International Conference on Russian America. The Limestone Press. 1987.
- Plastic Pallets. Rand MHE. 2003. [www.randmh.com](http://www.randmh.com).
- Plastics Recycling Research Laboratory  
Santa Clara University. Recycled Plastics. Plastics Recycling Research Laboratory. 2003. <http://webtest.engr.scu.edu>.
- Plastics Waste. Californians Against Waste. 2003. [www.cawrecycles.org](http://www.cawrecycles.org).
- Population Information Program. Solutions of a Water-Short World. John Hopkins School of Public Health. 1998.
- Prepared food; Beverages, Spirits, Tobacco. ISBC. 2003. [www.isbc.com/codes/prepared\\_food.cfm](http://www.isbc.com/codes/prepared_food.cfm).
- Preparing for California's Next Drought Changes Since 1987-92 July 2000. Department of Water Resources State of California. 2000. <http://watersupplyconditions.water.ca.gov/rep1987>.
- Pre-Treatment & Post-Treatment Technologies in Desalination. Israel Desalination Society. Israel. 2002.
- Private Enterprise Policy. Denali Commission. 2003.
- Profit Rose 2.8% at Pepsi Bottling. The New York Times. 2003.
- Proforma Invoice. Norland Int'l Inc. 2000.
- PS-West Container Specifications. PS-West. 2003. [www.ps-west.com/container.htm](http://www.ps-west.com/container.htm).
- Purchase Agreement for Raw Water in Bulk for Export. City and Borough of Sitka Alaska. 2003.
- Radical Group Behind Incendiary Devices At Mich Water Co. Wall Street Journal. 2003.
- Rate List from AK, USA to Tokyo Japan. Maersk Sealand. 2003. <http://rates.etransport.com>.
- Recycler's World Traders and Recyclers Director. Recycler's World. 2003. [www.recycle.net/trade/rs0006](http://www.recycle.net/trade/rs0006).
- Report on Metropolitan's Water Supplies. The Metropolitan Water District of Southern California. 2003.
- Report: Surge in Bottled Water Popularity Threatens Environment. California Department of Conservation. 2003. [www.consrv.ca.gov/index/news](http://www.consrv.ca.gov/index/news).
- Review of World Water Resources by Country. FAO. Italy. 2003.
- Rubenstein, Carin. IN Business; No.1 in the Bottled Water Pack. New York Times. 2003.
- Rudge, David. Water Resources Low as Rainy Season Begins. Jerusalem Post. Isreal. 2003.



- <http://pqasb.pqarchiver.com/jpost/doc/436426751.html?MA C=34593f4e81433a489a25b475d&>.
- Rudge, David. New Desalination Plan Planned for the Desert. Jerusalem Post. Israel. 2003. <http://pqasb.pqarchiver.com/jpost>.
- Rudge, David. The Return of Lake Kinnert. Jerusalem Post. Israel. 2003. <http://pqasb.pqarchiver.com/jpost>.
- Rudge, David. Water Chief Increases Farmers' Quotas. Jerusalem Post. Israel. 2003. <http://pqasb.pqarchiver.com/jpost>.
- Rural Water Supply and Sanitation. The World Bank. 2003.
- Russian Periods (1587-1867). University of Alaska Anchorage. 2003. [www.uaa.alaska.edu/history/timeline1.html](http://www.uaa.alaska.edu/history/timeline1.html).
- Samin, Lisa. Turning Thoughts Into Food. Jerusalem Post. Israel. 2002. <http://pqasb.pqarchiver.com/jpost>.
- San Diego Water Authority Infrastructure Environmental Impact Reports. San Diego County Water Authority. 2003.
- Santa Clara University. Characterizing Successful Recycling Companies.
- Santa Clara University; <http://webtest.engr.scu.edu/current.htm>
- Santa Clara University. 2003.
- Sawmill Cove Industrial Park Current Tenant-Sitka Beverage Corporation. Sawmill Cove Industrial Park. 2003. [www.sawmillcove.com/sitkabeverage.shtml](http://www.sawmillcove.com/sitkabeverage.shtml).
- Schenkeveld, Maarten M. Seawater and Brackish water desalination in MENA and CA, World Bank sponsored project. DHV Water. Netherlands.
- Seawater Desalination Project. Tampa Bay Water. 2003. [www.tampabaywater.org/MWP/MWp\\_Projects/Desal/Project\\_overview.htm](http://www.tampabaywater.org/MWP/MWp_Projects/Desal/Project_overview.htm).
- Seawater Desalination Project Question and Answers. Tampa Bay Water. 2003.
- Secretary Norton Signs Historic Colorado River Water Pact. U.S. Department of the Interior. 2003. [www.doi.gov/news/031016b/htm](http://www.doi.gov/news/031016b/htm).
- Seeking Future Water Supplies, Calif. Turns Attention to Ocean. The Capital Press. 2003. [www.crcwater.org/issues14/20030326oceans.html](http://www.crcwater.org/issues14/20030326oceans.html).
- Semiat, Raphael. Desalination: Present and Future. International Water Resources Association. Israel. 2000.
- Sessions, Christina. New Asia-Anchorage Ship Link May open Doors Save Money. Alaska Journal of Commerce. 2003. [www.Alaskajournal.com](http://www.Alaskajournal.com).

- Shahid Chaudhry. Unit Cost of Desalination. California Energy Commission. 2002.
- Shaul, D'vora Ben. Grain Exporters are, in effect, water exporters- and that is a very big problem. Jerusalem Post. Canada. 2001.
- Sicher, John. Beverage Digest Volume 42, No. 6. Beverage Digest Company LLC. 2003.
- SinPari Trading Co. LLC Products Source Alaska Water. SinPari Trading Co. LLC.
- Sitka Beverage Corporation Informational Facts. Sitka Beverage Corporation. 2001. [www.sitkabeverage.com/main\\_fla.html](http://www.sitkabeverage.com/main_fla.html).
- Smith, Vernon L.; Kiesling, Lynne. Socket to California. Wall Street Journal. 2003.
- Source Book of Alternative Technologies for Freshwater Augmentation in Small Island Developing States. United Nations Environment Programme. 2002. [www.siwin.org/reviews/swr0004/swr0004d3.html](http://www.siwin.org/reviews/swr0004/swr0004d3.html).
- Sources and Use of Water in 1995. USGS. 1995. <http://ga.water.usgs.gov/edu/octopus.html>.
- State Waste Board Approves Plastics Recycling Agreements with 21 Companies. California Integrated Waste Management Board. 2001.
- Still Waters Desalination Units I-- Series Sail on Board, Oil Production Platform or Land Based Models. HTS Manufacturing. [www.purehts.com](http://www.purehts.com).
- Stockholm International Water Institute; Stockholm Environment Institute. Proceeding Mar del Plata 20 Year Anniversary Seminar Water for the next 30 years Averting the looming water crisis. Stockholm International Water Institute. Sweden. 1997.
- Summary of Desalination Costs. Monterey Peninsula Water Management District. 1997. [http://www.mpwmd.dst.ca.us/seir/dap/t\\_a\\_7.htm](http://www.mpwmd.dst.ca.us/seir/dap/t_a_7.htm).
- Summary-May 14,2003 California Bay-Delta Public Advisory Committee Water Supply Subcommittee. California Bay-Delta Public Advisory Committee Water Supply Subcommittee. 2003.
- Swift, Dan. Alaska Science Forum. University of Alaska Fairbanks. 1976.
- Synthesis GEO-3. United Nations Environment Programme. 2002. [www.unep.org](http://www.unep.org).
- Tampa Bay Water Cancels Special Meeting. Tampa Bay Water. 2003. [www.tampabaywater.org](http://www.tampabaywater.org).

- Terhune, Chad. Suntory, Danone to Merge U.S. Water-Delivery Unites. Wall Street Journal. 2003.
- The Alaska Legal Resource Center. 18 AAC 31.740. Bottled Drinking Water. 2003.  
<http://touchngo.com/lglcntr/akstats/AAC/Title18/Cahpter031/Section740.htm>.
- The Alaska Legal Resource Center. 18 AAC 31.730. Glacial Ice and Ice Manufacturing. 2003.  
<http://touchngo.com/lglcntr/akstats/AAC/Title18/Cahpter031/Section730.htm>.
- The Bottled Water Store. 2003.
- The City of Adak. Adak Is Open to the World. The City Adak. 2003.
- The Denali Commission Act of 1998. Denali Commission. 1998.  
[www.denali.gov/content/act/statewide.htm](http://www.denali.gov/content/act/statewide.htm).
- The Right to Water. World Health Organization. 2003.
- The State of Plastics Recycling. Californians Against Waste. 2003.  
[www.cawrecycles.org](http://www.cawrecycles.org).
- The Wall Street Journal. Russia Wimm-Bill-Dann: Talks With Danone, Nestle, PepsiCo. Wall Street Journal. Russia. 2003.
- The World Bank Group. World Bank Water Supply and Sanitation: Related Sites. The World Bank. 2003.
- Title 18 Environmental Conservation Chapter 80 Drinking Water. Alaska Department of Environment Conservation. 2003.  
[www.state.ak.us/dec/title18/aac80ndx.htm](http://www.state.ak.us/dec/title18/aac80ndx.htm).
- United Nations Children Fund. UNICEF Strategies in Water and Environmental Sanitation. UNICEF. 1995.
- U.S. Congress Office of Technology Assessment (U.S. Congress). 1992. Alaskan Water for California? The Subsea Pipeline Option. January. 11 pp.
- USGS Alaska District Introduction. USGS. 2003.  
<http://water.usgs.gov/pubs/wdr/WDR-AK-01-1/htdocs/Intro.htm>.
- Verran, Julie. Alaskan Firm Targets Water From Gualala, Albion Rivers. Independent Coast Observer; Sierra Club. 2003.  
[www.redwood.sierraclub.org/Campaigns/Water/Water\\_AB858\\_Arti](http://www.redwood.sierraclub.org/Campaigns/Water/Water_AB858_Arti).
- Wanger, Alfred L.; Dettmer, Alison; Luster, Tom. Re: Presentation of Draft Report on Seawater Desalination and the California Costal Act. California Coastal Commission. 2003.
- Water 2025: Preventing Crises and Conflict in the West. National Water Resources Association. 2003.  
[www.nwra.org/index/cfm](http://www.nwra.org/index/cfm).

- Water and Wastewater Technologies Export Market Plan. U.S. Department of Commerce. 2002.
- Water Desalination Task Force. Water Desalination Task Force Findings and Recommendations. California Department of Water Resources. 2003.
- Water Export: Commercialization. Friends of Gualala River. 2003. [www.gualalariver.org/export/commerce.html](http://www.gualalariver.org/export/commerce.html).
- Water Fact Sheet Looks at Threats, Trends, Solutions. Pacific Institute. 2003.
- Water Fact Sheet Looks at Threats, Trends, Solutions. Pacific Institute. 2003. [www.pacinst.org/world\\_water\\_facts.htm](http://www.pacinst.org/world_water_facts.htm).
- Water News "Private Water, Public Misery". Water Observatory. 2003. [www.waterobservatorynews.org/news/news.cfm](http://www.waterobservatorynews.org/news/news.cfm).
- Water Resources Program. Alaska Department of Natural Resources. 2003.
- Water.com. Office Coffee Service. SWG Inc.. 2002. [www.water.com/coffee](http://www.water.com/coffee).
- Water-Anchorage. The City Of Anchorage. Com. 2003.
- Wateright Glossary. Wateright. 2003. [www.wateright.org/waterightscripts/glossary12.asp](http://www.wateright.org/waterightscripts/glossary12.asp).
- Water-related Links. World Health Organization. 2003.
- Welcome to the Denali Commission. Denali Commission. 2003. [www.denali.gov/content/home.html](http://www.denali.gov/content/home.html).
- What guidance does FDA have for manufacturers of bottled waters?. FDA. 2003. <http://m.cfsan.fda.gov/~dms/qa-ind4c.html>.
- WHO; Water Resource Quality. World Health Organization. 2003.
- World Bank Water Supply and Sanitation: Project Lending. The World Bank. 2003.
- World Bank. Water Supply and Sanitation. The World Bank. 2003. [www.worldbank.org/html/fpd/water/](http://www.worldbank.org/html/fpd/water/).
- World Water, SA. 2003. [www.worldwatersa.com/management.html](http://www.worldwatersa.com/management.html).
- WRI Project: EarthTrends: The Environmental Information Portal. World Resources Institute. 2003. [http://projects.wri.org/project\\_description.cfm?ProjectID=48](http://projects.wri.org/project_description.cfm?ProjectID=48).
- Zhou, Yuan; Tol, Richard S. J. The Implications of Desalination to Water Resources in China-an Economic Perspective. Center for Marine and Climate Research Hamburg University. China. 2003.

## Appendix B—Conversion Table

Unit	Metric		English	Unit
Cubic Meters	1,000,000	==>	810.7	Acre Feet
Cubic Meters	1,000,000	==>	264,200,000	Gallons
Cubic Meters	1,000	==>	264,200	Gallons
Cubic Meters	1	==>	264.2	Gallons
Cubic Meters	1,233	<==	1	Acre Foot
Acre Foot	1	==>	325,900	Gallons
Cubic Meters	3.785	<==	1,000	Gallons
Cubic Meters	3,785	<==	1,000,000	Gallons
Liters	3,785,000	<==	1,000,000	Gallons
Acre foot	3.07	<==	1,000,000	Gallons
Cubic Meters	3,785,000	<==	1,000,000,000	Gallons
Liters	3,785,000,000	<==	1,000,000,000	Gallons
Liters	1,000,000	==>	264,200	Gallons
Liters	1,000	==>	264.2	Gallons
Cubic Meters	28.32	<==	1,000	Cu Ft
<b>\$/Acre Foot =&gt;</b>	<b>\$/1000 gallons =&gt;</b>		<b>\$/cubic meter</b>	
\$ 400	\$ 1.23		\$ 0.32	
\$ 600	\$ 1.84		\$ 0.49	
\$ 800	\$ 2.45		\$ 0.65	
\$ 850	\$ 2.61		\$ 0.69	
\$ 860	\$ 2.64		\$ 0.70	
\$ 900	\$ 2.76		\$ 0.73	
\$ 1,000	\$ 3.07		\$ 0.81	
\$ 1,200	\$ 3.68		\$ 0.97	
\$ 1,600	\$ 4.91		\$ 1.30	
\$ 2,000	\$ 6.14		\$ 1.62	
\$ 2,400	\$ 7.36		\$ 1.95	
\$ 2,800	\$ 8.59		\$ 2.27	
\$ 3,200	\$ 9.82		\$ 2.60	
\$ 3,600	\$ 11.05		\$ 2.92	
\$ 4,000	\$ 12.27		\$ 3.24	
<b>\$0.00/Gallon</b>	<b>\$/1000 Gallons</b>		<b>\$/Acre Foot =&gt;</b>	<b>\$/cubic meter</b>
\$ 0.001	\$ 1.00		\$ 326	\$ 0.26
\$ 0.002	\$ 2.00		\$ 652	\$ 0.53
\$ 0.003	\$ 3.00		\$ 978	\$ 0.79
\$ 0.004	\$ 4.00		\$ 1,304	\$ 1.06
\$ 0.005	\$ 5.00		\$ 1,630	\$ 1.32
\$ 0.006	\$ 6.00		\$ 1,955	\$ 1.59
\$ 0.007	\$ 7.00		\$ 2,281	\$ 1.85
\$ 0.008	\$ 8.00		\$ 2,607	\$ 2.11
\$ 0.009	\$ 9.00		\$ 2,933	\$ 2.38
\$ 0.010	\$ 10.00		\$ 3,259	\$ 2.64

## **Appendix C—Bulk (Raw) Water Tanker Export—Sitka, AK to Long Beach, CA**

## Bulk (Raw) Water Tanker Export - Sitka, AK to Long Beach, CA

### Basis of Estimate (Control Board):

1	Raw Water Supply Per Year	28,000 Acre Foot			
2	Tanker Size	350,000 Barrel	=	45.1 Acre Foot	= 14,700,000 Gallon
3	Distance Between Ports	2112 Nautical Miles			
4	Average Speed of Tanker	22 Knots			
5	Travel Time	96 Hours	=	4.0 Days	
6	Tanker Deliveries Per Year	621			
7	Number of Tanker Deliveries Per Day	1.70			
8	Time Between Deliveries Per Tanker	10 Days			
9	Tankers Needed to Meet Supply	18			
10	Deliveries Per Tanker Per Year	34.5			
11	Days Out of Service for Annual Maintenance	20.2 Per Tanker			
12	Storage Capacity	20,000,000 Gallon			
13	Cost of Raw Water	\$0.0100 Gallon			

Note: Capital costs for port improvements are estimated for handling and loading 2 tankers only. Except for the capital cost of tankers, the control board does not revised the capital costs for additional port facilities for larger tankers and/or more tanker slips.

### Capital (Investment) Cost

	<u>Quantity</u>	<u>Unit of Measure</u>	<u>Unit Cost</u>	<u>Extended Total</u>
Used Single Hull Tankers w/ Ballast Tanks and Pumps	18	Each	\$ 8,000,000	\$ 144,000,000
<u>Sitka</u>				
Loading Dock for 2 Tankers & Related Apputenances	1	Lump Sum	\$ 8,200,000	\$ 8,200,000
On-Site Storage Tanks or Off-Shore Storage Bags	20,000,000	Gallon	\$ 1	\$ 20,000,000
Pumping Facilities (Auumed Tankers Will Be Gravity Feed)	1	Lump Sum	\$ -	\$ -
4' Pipeline - Existing Aqueduct to Dock Site	2,000	Linear Foot	\$ 400	\$ 800,000
<u>Long Beach</u>				
Loading Dock for 2 Tankers & Related Apputenances	1	Lump Sum	\$ 12,000,000	\$ 12,000,000
Pumping Facilities and Related Apputenances	1	Lump Sum	\$ 5,000,000	\$ 5,000,000
4' Pipeline - Long Beach Port to the Region's Water System	50,000	Linear Foot	\$ 400	\$ 20,000,000
		Subtotal:	\$	210,000,000
Administration	5%			\$ 10,500,000
Engineering	20%			\$ 42,000,000
Permitting	15%			\$ 31,500,000
Contingency	25%			\$ 52,500,000
		Subtotal:	\$	136,500,000

**Total: \$ 350,000,000**

Rounded Up to the Nearest 5 Million

**Annualized Capital Cost at 4% over 20 years: \$26,000,000**

Rounded Up to the Nearest Million

### Cost of Raw Water Per Tanker Per Round Trip

Blue Lake (Sitka)	14,700,000	Gallon	\$	0.0100	<b>\$ 147,000</b>
-------------------	------------	--------	----	--------	-------------------

### Operating Costs Per Tanker Per Round Trip

Load Tanker w/ Raw Water (Sitka)	2	Day	\$	6,500	\$ 13,000
Tanker Travel (Payroll)	8	Day	\$	7,500	\$ 60,000
Tanker Travel (Fuel)	8	Day	\$	6,000	\$ 48,000
Tanker Travel (Other)	8	Day	\$	500	\$ 4,000
Unload Tanker (Long Beach)	2	Day	\$	6,500	\$ 13,000
Miscellaneous	1	Lump Sum	\$	5,500	\$ 5,500

Note: Assumes 4 day travel time each way between ports.

Subtotal: \$ 143,500

Administration		0.5%		\$	718
Insurance		0.25%		\$	359
Routine Maintenance / Minor Repairs and Replacements		0.75%		\$	1,076
Rate of Return		5.5%		\$	7,893
Wharfage Fee	61,248	Ton	\$	0.075	\$ 4,600
Conservation Fee to the State of Alaska	45.0	Acre Foot	\$	10	\$ 450
Contingency		2%		\$	2,870

Subtotal: \$ 17,965

**Total: \$ 162,000**

Rounded Up to the Nearest Thousand

### Major Maintenance Per Tanker Per Year

Out of Service Maintenance (1% of the Initial Purchase Value)	1%	Each	\$	8,000,000	<b>\$ 80,000</b>
---	----	------	----	-----------	------------------

### Annual Cost Summary (Including Amortized Capital Cost)

Amortized Capital	1	Lump Sum	\$	26,000,000	\$ 26,000,000	11.9%
Raw Water Purchase	621	Round Trip	\$	147,000	\$ 91,238,280	41.5%
Operations	621	Round Trip	\$	162,000	\$ 100,548,309	45.8%
Major Maintenance	18	Tanker	\$	80,000	\$ 1,440,000	0.7%

**Total: \$ 220,000,000**

Rounded Up to the Nearest Million

**Cost Per Acre Foot \$ 7,900**

Rounded Up to the Nearest Hundred

**Cost Per 1000 Gallon \$ 24.11**

**Cost Per Gallon \$ 0.0241**